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Evaluation of Stimuli Along a Hierarchy Under Additive and Geometric Progressive-Ratio Schedules

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Evaluation of Stimuli Along a Hierarchy Under Additive and Geometric Progressive-Ratio Schedules

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This study was primarily intended as a comparative investigation of the difference between participants' responses to a task under two progressive-ratio schedules (i.e., geometric and additive). Furthermore, the study served as an examination of the variations in response levels across an array of preferences (HP, MP, LP) under the two increasing schedule requirements. Three individuals, all males, ranging between the ages of 16 years old and 28 years old participated in the study. The study utilized a MSWO preference assessment to identify the stimuli for each participant. The three identified stimuli were categorically ranked as HP, MP, and LP to be analyzed during three independent reinforcer assessments. An alternating treatment design was conducted to assess the stimuli. The additive and geometric progressive ratio schedules were conducted in a single-operant arrangement for each reinforcer assessment. The dependent variables collected during the reinforcer assessment were: (a) the breakpoint, (b) responses per minute, and (c) the cumulative number of responses. The data were further analyzed using mean breakpoint, average response per minute, total tasks correct, cumulative number of tasks completed, and sessions terminated.

The results of the study support the suggestion of Glover et al. (2008): namely, that individuals with ASD may vary their response levels across a hierarchy of stimuli under increasing schedule requirements. The results for two of three participants are consistent with the research on reinforcer assessments under progressive ratio schedules. The results derived from 2/3 participants' assessments support the notion that HP stimuli yields a higher mean BP compared to either the MP and LP reinforcer (DeLeon et al., 2009; Call et al., 2012; Glover et al., 2008). In addition, the

MP stimuli supported higher mean break points than the LP stimuli for 2/3 participants (see also Call et al., 2012). The findings for one participant are consistent with previous findings found in the literature. One participants' response on tasks corresponded with the ranking of the stimuli. The HP stimulus supported higher mean BP, more total responses, and the highest accuracy of task completion. In regard to the results of the PR schedule, for 2/3 participants, the highest BP was obtained during the geometric schedule. However, across all 3 participants, considerably more responses were observed under the additive schedule for the differing levels of preferred stimuli.

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Chapter One: Introduction

Reinforcement is a fundamental principle of behavior analysis. The essential principle is defined as an environmental consequence applied contingent on a behavior, which increases the future frequency of that behavior (Cooper, Heron, & Heward, 2007). The two primary types of reinforcement are positive and negative reinforcement. Positive reinforcement involves the addition of a reinforcing stimulus following a behavior, which makes the behavior more likely to occur in the future. In contrast, negative reinforcement occurs when a response or behavior is strengthened by the removal of an aversive stimulus or the complete avoidance of the stimuli before presentation. More recently, the examination of basic reinforcement principles has been extended to include the study of dimensions of reinforcement and their impact on behavioral responses (Falcomata, Cooper-Brown, Wacker, Gardner, & Boelter, 2010; Hoch, McComas, Johnson, Faranda, & Guenther, 2002; Neef & Lutz, 2001; Trosclair-Lasserre, Lerman, Call, Addison, & Kodak, 2008). Specifically, researchers have manipulated dimensions of reinforcement in various ways to affect behavioral outcomes. The most commonly examined dimensions of reinforcement are: quality of reinforcement, magnitude of reinforcement, rate of reinforcement, effort required to obtain reinforcement, and the delay to receive reinforcement.

Incorporating the dimension of quality to increase response rates in applied settings is a positive practice within the field of applied behavior analysis (DeLeon & Iwata, 1996; Zook, 2010). Several researchers have reported the effects that high quality reinforcers have on maintaining behavioral responses during an increase of response efforts or leaned schedules of reinforcement (Glover, Roane, Kadey, & Grow, 2008; Gwinn et al., 2005; Penrod, Wallace, & Dyer, 2008; Zook, 2010). The use of high quality reinforcers aided in behavioral momentum of task completion yielded higher on task performance (Mace, Mauro, & Boyajian, 1997; Volkert, Lerman, Trosclair,

Addison, & Kodak, 2008). Inconsistencies with participants' compliance to brief praise as reinforcement were reported by researchers; however, by increasing the quality of reinforcers, such as pairing food with praise or enthusiastic praise, the accuracy of responses to known tasks increased (Volkert et al., 2008). A number of studies concluded that reinforcer quality has an impact on the frequency of responses and is the most consistent determinant of choice (Bourret, Iwata, Harper, & North, 2012; Mace et al., 1997; Neef, Mace, & Shade, 1993; Neef, Shade, & Miller, 1994). It is common for researchers to manipulate quality by comparing high quality to low quality reinforcers (Ahearn et al., 2003; Athens & Vollmer, 2010; Bowman et al., 1997; Mace et al., 1996; Mace et al., 1997; Neef et al., 2005; Volkert et al., 2008). These findings suggest that allowing individuals with developmental disabilities to select their own activities, tasks, and reinforcers is influential on behavioral acquisition or behavior reduction (Lerman, Kelley, Vorndran, Kuhn, & LaRue, 1997).

In the past 25 years, a variety of methods have been used to identify reinforcers for individuals with disabilities, such as the single-stimulus method (SS; Pace, Ivanic, Edwards, Iwata & Page, 1985), the paired- stimulus method (PS; Fisher, Piazza, Bowman, Hagopian, Owens, & Slevin, 1992), the multiple stimulus with replacement (MS; Windsor, Piche, & Locke, 1994), and the multiple stimulus without replacement (MSWO; DeLeon & Iwata, 1996). A preference assessment is conducted to determine the items that may be plausible as reinforcers. After conducting the assessment, items are ranked based on selection, or engagement (i.e. duration), and the ranking of items provides a hierarchy of preference. Typically, the preference of items will be referred to as high- preference (HP), moderate-preference (MP), and low-preference (LP) based on their ranking of selection. This identification method will be applied in the current future study. For that reason, it is best practice to identify the accurate preference assessment to identify a

hierarchy of HP, MP, and LP stimuli. In a study by Roscoe, Iwata, and Kahng (1999) that compared methodologies for assessing preferences in a variety of systematic assessments, the PS method was identified a more accurate hierarchy assessment than the SS method. As Linn (2016) described the procedure of a MS assessment may not allow a true analysis of the hierarchy due to the ability to repeatedly select a specific stimulus (i.e., HP); however, the MSWO procedure would correct that bias by removing it from the selection process. In an investigation of preference assessments by Kang, O'Reilly, Giulio, Falcomata, Sigafoos, and Xu (2013), the authors concluded that the PS and MSWO method of a preference assessment results in the best prediction of items as reinforcers.

Although a preference assessment is conducted, the method only identifies stimuli as preferred, thus the function as a reinforcer has not been systematically examined; therefore, a reinforcer assessment is necessary to assess the reinforcer potency of the items. The effectiveness of a reinforcer can be tested in a variety of methodological approaches, such as the schedule of reinforcement or the arrangement of presentation (i.e., single-schedule or concurrent-schedule). Several researchers have examined the reinforcer potency through dense schedules of reinforcement (i.e., FR1); the reinforcers may appear to have similar reinforcer potency under a low schedule requirement, however when compared under a leaner schedule of reinforcement the stimuli may show their value as a reinforcer (Roane, Lerman, & Vorndran, 2001; Tustin, 1994). For example, Tustin (1994) manipulated the schedule of reinforcement by increasing a FR schedule for two stimuli in a reinforcer assessment, in which a clear preference of one item appeared under the schedule requirement. After the findings of Tustin (1994) a schedule of reinforcement was examined by Roane et al. (2001) in which, the number of responses required to receive reinforcement is increased systematically: a progressive-ratio (PR) schedule. A breakpoint signals the last completed schedule requirement of a PR schedule. In regard to the arrangement of

reinforcer assessment, a single-schedule arrangement means a learner can respond to one schedule to gain access to a stimulus; for example, an adult can finish one puzzle piece to gain access to a video for 30s. Whereas manipulating stimuli under a concurrent schedule places two (e.g., HP, LP) or more (e.g., HP, MP, LP) stimuli in direct competition. For example, an adult will be provided a choice between two tasks to complete which correlate to different preferred items; these choice options correspond to colors, so the participant will associate the options to each stimulus (i.e., HP or LP). Such as, an adult given the choice of putting away one dish for the LP stimuli (red cue) or putting away one clothing for the HP (blue cue) stimuli (Francisco, Borrerom Sy, 2008; Glover, Roane, Kadey, & Grow, 2008). The result of the concurrent arrangement typically provides a higher rate of responses towards the more preferred option, which is a general hypothesis of a reinforcer assessment (Hagopian, Long, & Rush, 2004).

While the foundation has been provided for PR schedules of reinforcement, there is still a need of research in the applied setting to refine the methodological practices that are currently implemented. The purpose of this study is to create more explicit practices in the applied setting by investigating a hierarchy of preferences (i.e. HP, MP, LP) under two PR schedules of reinforcement.

Research Questions

The study will address the following research questions:

1. Will the breakpoint provide the best data analysis to determine the more effective schedule and stimulus?

2. Will the hierarchy of stimuli be apparent in the data collected? Will the HP stimulus have more reinforcer potency than the MP or LP stimulus?

3. Will different breakpoints be yielded under the additive and geometric PR schedules for the stimuli?

4. Will an LP stimulus be an effective reinforcer if it is a stimulus that was chosen from a preference assessment rather than the last ranking stimuli?

Chapter Two: Review of Literature

The primary purpose of this chapter is to identify, review, and summarize research on progressive-ratio schedules across a hierarchy of preference for individuals with ASD. By analyzing the resources included in this review I hope to extend the literature by providing more analysis to the methods applied to stimulus rankings, thus improving the identification and generalization studies in this area of research. Furthermore, I hope to improve the implementation of PR schedules in the applied setting by examining two PR algorithms along a hierarchy of stimuli. Lastly, extend the knowledge and practice of HP, MP, and LP stimuli in a progressive schedule of reinforcement.

Method

Search. First, an electronic database search was conducted using four databases: Academic Search Complete, PscyINFO, Education Resource Information Center (ERIC), and CINAHL Plus with Full Text. The databases were searched using the following terms: progressive rate (or progressive ratio schedule) entered in the first search window with reinforcer assessment (or preference assessment) entered in the second search window. Databases were narrowed to peer-reviewed journals from 2000 to 2016 in the English language. After duplicates were removed, there were 30 total studies selected for further review. The articles were reviewed for inclusion and exclusion criteria to determine inclusion in the review.

Inclusion-Exclusion Criteria. An article was included after meeting the following criteria: (a) the study included at least one participant with a diagnosis of autism spectrum disorder (ASD), (b) the procedure involved a preference assessment of edible or tangible stimuli (i.e. articles that used people as reinforcers were excluded), (c) the reinforcing efficacy of each stimulus

was evaluated under a progressive-ratio schedule with the break point recorded, (d) researchers utilized an experimental design and methodology that allowed for analysis of the intervention on the participant's response rates, (e) articles that manipulated any dimension of reinforcement, other than quality or rate, were excluded (i.e. magnitude).

The inclusion criteria were applied to the 30 articles, and references of those selected articles were reviewed for eligibility criteria. There were seven additional articles that met eligibility criteria; thus, the inclusion criteria were applied to 37 articles. In total, eight studies met the inclusion criteria and were selected for review. The eight studies included a total of 29 participants.

Coding and Summary of Studies. The eight studies were coded using a data sheet designed for this review; the data sheet recorded the methods and results of each article. Studies were summarized according to the following features (see Table 1): (a) participant characteristics (e.g. number of participants, age range, diagnosis); (b) preference assessment (preference assessment/s, range of preferences, stimuli); (c) design (PR schedule algorithm, research design) and (d) outcomes.

Procedures of the preference assessments were categorized by two characteristics: the assessment delivered (single stimulus, paired-choice, MSWO, free-operant), and the range of preferences assessed for reinforcer efficacy (high-preferred, HP; moderately preferred, MP; low preferred, LP). The preference of stimuli were also discriminated by a percentage if not labeled as HP, MP, or LP. The articles were categorized by the progressive design of the schedule. The PR schedules algorithm was stated as either rapid or gradual and geometric or additive. The number of exposures to each PR step dictates if it was rapid or gradual. A rapid schedule illustrates one exposure of each schedule requirement before the schedule progresses (i.e. PR1, PR2, PR3),

whereas gradual illustrates two exposures of each schedule requirement before the schedule progresses (i.e. PR1, PR1, PR2, PR2). Furthermore, the algorithm of the PR arrangement was analyzed as additive or geometric. A geometric schedule involves a progression of multiplying the response requirement by a constant (i.e. PR2, PR4, PR6), and additive progression is the addition of a constant to the prior response requirement (i.e. PR 1, PR2, PR3). The remainder of the chapter will present the results of the articles in three sections: type of preference assessment, ranking of stimuli along the hierarchy of preference, and the PR design. Each section will include a summary of the studies representative of each category; a discussion and suggestions for future research will follow. A summary of the studies that I reviewed for this chapter is presented in Table 1.

Table 1
Summary of reviewed studies

Study Citation	Participants	Preference Assessment	Design	Outcomes
Call, Trosclair-Lasserre, Findley, Reavis, & Shillingsburg (2012)	N = 7, 5-18 years old, ASD	• PS • Daily • MSWO • Hierarchy of preference assessed Edible and leisure items	Rapid, geometric schedule (PR 1, PR2, PR 4, PR8…)	LP resulted in low break points; HP resulted in high break points for both the MSWO and PS preference assessments PS revealed stimuli responsive of highest break point for 7/7 participants, while MSWO highest rank item reached highest break point for 3/7 participants

Table 1 Continued

DeLeon, Frank, Gregory, & Allman (2009)	N= 4, 9-20 years old, ASD	• PS • HP (1-4) • MP (5-8) • LP (9-12) • Leisure items	Rapid, additive schedule (PR1, PR2, PR3…)	Greater response rates for the HP stimuli than LP stimuli
Francisco, Borrero, & Sy (2008)	N=3, 3-5 years old, ASD	• PS • HP (80%) • LP (22%) • Edible items	Rapid, additive schedule (PR2, PR4, PR6, PR8…) Consecutive single schedule PR sessions	2/3 participants responded to LP stimuli in the singular arrangement Greater break points for HP stimuli than LP stimuli in concurrent schedule, but LP stimuli did serve as low reinforcer under the PR schedule
Glover, Roane, Kadey, & Grow (2008)	N= 3, 10- 16 years old, ASD	• PS • HP (80-100%) • LP (0- 25%) • Leisure items	Rapid, additive schedule (PR1, PR2, PR3…) Singular (LP) and Concurrent (HP/LP) cued schedule arrangements	Participants responded more for the HP stimuli than the LP in both the singular- and concurrent-schedule arrangements Similar breakpoints were obtained within both schedules
Penrod, Wallace, & Dyer (2008)	N= 4, 5- 8 years old, ASD	• SS • PS • HP (80-100%) in SS & PS) • LP (40%) in PS	Gradual, additive (PR1, PR1, PR2, PR2, PR3, PR3….) Multiple baseline design	¾ participants responded more for the HP stimuli than the LP stimuli under the PR schedule

Table 1 Continued

		• Edible items	across participants	HP produced higher break points, but LP stimuli did maintain responding under FR1 schedule
Reed, Luiselli, Magnuson, Fillers, Vieria, & Rue (2009)	N= 1, 19 year old, ASD	• PS • MSWO • Free-operant • Edibles	Rapid, geometric schedule (PR1, PR1, PR2, PR2, PR5, PR5, PR10, PR10, PR20, PR20, PR30, PR30) Multi-element design	The three preference assessments established the least and most preferred items, though varied preference hierarchies. Moderately preferred items seem to serve as reinforcers
Roane, Lerman, & Vorndran (2001)	N= 4, 13- 18 years old, ASD/DD	• PS • 2 HP items (among top 3 of PC) • 50-90% • Tangibles	Rapid, additive schedule (PR1, PR2, PR3…); Gradual, additive schedule (PR1, PR1, PR2, PR2, PR3, PR3…); Gradual, geometric schedule (PR1, PR1, PR2, PR2, PR5, PR5, PR10, PR10, PR20…)	One stimulus was associated with greater response persistence under increasing schedule requirements for all participants.
Tiger, Toussaint, & Roath (2010)	N= 3, 3-7 years old, ASD	• PS • 3 HP items • Edibles	Multi-element design, single-operant arrangement;	A clear distinction between a choice of HP and no

Table 1 Continued

	Gradual, geometric schedule (PR1, PR1, PR2, PR2, PR4, PR4, PR8, PR8…) Multiple baseline design, single operant assessment for 3 participants with a further concurrent operant assessment for 1 participant	choice of HP on the break point. 2/3 of participants engaged in higher response rates during choice conditions when compared in PR assessment.

Results

Preference Assessments. Researchers have determined preference of reinforcers prior to a PR reinforcer assessment through various assessment methods, such as single stimulus (SS), paired stimulus (PS), multiple stimuli without replacement (MSWO), free- operant (FO); however, majority of the articles in this literature review administered a PS preference assessment. Five studies conducted a PS preference assessment (Fisher et al., 1992) to identify an array of preferred stimuli for each participant (DeLeon, Frank, Gregory, & Allman, 2009; Francisco et al., 2008; Roane et al., 2001; Tiger, Toussaint, & Roath, 2010). Glover et al. (2008) used a PS preference assessment with three participants to identify HP and LP stimuli for the arrangement of single and concurrent presentations. The stimuli included in the assessment were based on caregiver report. Similar to Glover and colleagues, Francisco et al. (2008) evaluated the potency of edible reinforcers through a paired-stimulus preference assessment. Tiger et al. (2010) conducted a PS preference assessment followed by a daily pre-session brief assessment to determine which of the

three HP items would be included in the experimental session. The researchers were comparing conditions of choice and no- choice of HP items following the PR schedule completion.

Three studies conducted multiple preference assessments before examining the PR reinforcer assessment (Call, Trosclair- Lasserre, Findley, Reavis, & Shillingsburg, 2012; Penrod et al., 2008; Reed, Luiselli, Magnuson, Fillers, Vieira, & Rue, 2009). Call et al. (2012) conducted one PS preference assessment and daily multiple stimulus without replacement (MSWO) preference assessments for seven individuals with developmental disabilities. The PS preference assessment accurately assessed the preference of the stimuli based on the hierarchy of stimuli and the break points during the PR assessment. Based on the results of Call and colleagues' study, the PS was reported as "slightly better than the daily MSWO at identifying" (p. 775) the most effective reinforcer. Penrod et al. (2008) conducted two different preference assessments, single stimulus (SS) and PS, to achieve the hierarchy of 10 edible stimuli. The PS assessment was highlighted as an important choice over SS assessment gave the need of varied rankings of stimuli in response to the schedule requirement (Penrod et al., 2008). Researchers of one article included in the literature review examined three preference assessments to identify edible reinforcers; Reed and colleagues (2009) reviewed the hierarchy of stimuli through a PS assessment followed by a daily MSWO assessment and free-operant (FO) assessment for a single-case study. The results of the study suggest that the three preference assessments generated a relatively similar rank order of the reinforcers efficacy; the researchers do state that the PS assessment was used initially in comparison to daily preference assessments from the MSWO and FO. In addition to the results of the included articles, a literature review completed by Kang et al. (2013) found PS and MSWO methods adequately represented the reinforcement hierarchy of stimuli.

Hierarchy rankings. Some researchers have examined preference assessments for a variety of stimuli, which demonstrates the reinforcing efficacy of the assessed stimuli. The hierarchy rankings were analyzed in each article to investigate the given rankings (i.e., HP, MP, LP) assigned by the percentage of stimulus selection per number of trials. After reviewing the eight articles, an identification of rankings as HP, MP, or LP was explained with an unsystematic range of percentages for each label of stimuli preference. A total of five of the eight articles identified a hierarchy of stimuli though the scale of rankings varied in the articles (DeLeon et al., 2009; Francisco et al., 2008; Glover et al., 2008; Penrod et al., 2008; Roane et al., 2001). For example, stimuli chosen at least 80% of a preference assessment were identified as HP stimuli (Francisco et al., 2008; Glover et al., 2008; Penrod et al., 2008). However, Francisco et al. (2008) identified stimuli as LP if approached 22% of trials, whereas Glover et al. (2008) identified stimuli chosen on fewer than 25% of trials to 0% of trials as LP stimuli. In comparing these two articles, one researcher implicated a stimulus chosen 22% of trials was considered an LP stimulus (Francisco et al., 2008) whereas an LP item was identified as a possible stimulus if selected 0% during a preference assessment (Glover et al., 2008). Another discrepancy in the identification of hierarchy rankings was found between Penrod et al. (2008) and Roane et al. (2001); Penrod et al. (2008) identified the preference of an LP stimulus at 40%. However, in the Roane et al. (2001) study, researchers assessed two HP items as rankings between 50-90%. Therefore, an item ranking 50% was considered an HP stimulus in Roane et al.'s study whereas an item classified as an LP stimulus was selected 40% of trials in the study by Penrod et al. (2008). Therefore, the comparison of these two studies provides a little distinction between the percentages of LP and HP stimuli; this discrepancy could affect the overall findings when comparing the difference of reinforcer efficacy between an HP versus LP stimulus in a reinforcer assessment.

After conducting preference assessments, three of the eight researchers in this literature review identified the reinforcer efficacy for each stimulus. For Reed et al. (2009) the complete hierarchy of stimuli was examined in a reinforcer assessment after assessing the hierarchy of edibles across three preference assessments: PS, MSWO, and FO. Similarly, Call et al. (2012) examined the response to stimuli on a PR schedule to determine which of preference assessment, PS or daily MSWO, achieved the most accurate identification of a reinforcer. DeLeon et al. (2009) also ranked each stimulus of the preference hierarchy. The researchers examined the reinforcer efficacy of each stimulus by ranking items one to twelve with further categorization of items as HP between 1- 4, MP between 5- 8, and LP between 9- 12.

Progressive-ratio. In 2008, Roane reviewed applications of progressive ratio schedules in applied behavior analysis studies. A finding of the researcher was the variability of PR schedule algorithms in applied settings, and the need of procedural guidance to implement the appropriate algorithm in applied settings. The presentation of an algorithm has multiple arrangements: such as, (a) the number of exposures the participant has to the response requirement (rapid or additive), (b) how the schedule increases, (additive or geometric constant), (c) the size of the constant used to increase the schedule, and (d) the cessation of the session (Tiger et al., 2010).

I analyzed the eight articles by two algorithm arrangements: the number of exposures the participants has to the response requirement, and the increase of a schedule by said constant. As explained in the methods section, a rapid arrangement is one exposure to each schedule requirement, whereas the gradual method is two or more exposures to each schedule requirement before progression of the response requirement. The algorithm of the PR arrangements was analyzed as additive or geometric. A geometric schedule involves the multiplication by a constant, and additive is the addition of a constant. There are four arrangements of the PR schedule algorithm.

The arrangements are: rapid and geometric, rapid and additive, gradual and geometric, and gradual and additive. One study implemented a rapid and geometric PR algorithm (Call et al., 2012). Thus, the schedule requirement doubled after each delivery of reinforcement (i.e., PR1, PR2, PR4, PR8). The researchers stated the reasoning for selecting that PR schedule was to reach higher schedule requirements more rapidly to decrease the overall session length (Call et al., 2012).

Four researchers implemented a rapid and additive schedule (DeLeon et al., 2009; Francisco et al., 2008; Glover et al., 2008; Roane et al., 2001). DeLeon et al. (2009) arranged the PR schedules for each stimulus to reveal the relative reinforcer value of the stimuli. Francisco et al. (2008) implemented a rapid and additive schedule as it represented a more natural delivery of reinforcement in respect to a gradually thinning reinforcement schedule within each session. A rapid, additive PR algorithm was presented in a single- and concurrent- schedule arrangement by Glover and colleagues (2008). An independent PR schedule was compared in an alternating treatment design, so the schedule requirement increased for the selected stimuli independently of the other stimulus-reinforcer.

Three researchers implemented a gradual and geometric algorithm (Reed et al., 2009; Roane et al., 2001; Tiger et al., 2010). During the reinforcer assessment in Reed et al.'s study, researchers assessed participants in a multi-element design classified as rapid, additive (i.e., PR1, PR1, PR2, PR2, PR5, PR5, PR10, PR10, PR20, PR20, PR30). For the classification of this literature analysis, the PR algorithm applied in the reinforcement session was labeled as gradual (e.g. two exposures to the response requirement) and geometric (e.g., approximately multiplied by two); the topic of misclassified PR algorithms will be discussed further in the discussion session. Tiger et al. (2010) assessed reinforcer potency with exposure to a PR algorithm of gradual progression with a geometric multiplier of two (i.e., PR1, PR1, PR2, PR2, PR4, PR4, PR8, PR8,

PR16, PR16). Two researchers implemented a gradual and additive algorithm (Penrod et al., 2008; Roane et al., 2001). Penrod and colleagues based the PR schedule on procedures of Roane et al. (2001) and exposed the participants to two exposures of the schedule requirement to prevent rapid ratio strain (as described by Roane et al.). Few studies included in this literature review evaluated more than one type of PR algorithm; however, Roane and colleagues (2001) examined the effects of three algorithms on four participants. The schedule requirements were chosen through indirect observations and developed to provide rapid response rates; two exposures of the response requirements were provided to 3 of 4 participants to decrease the effects of rapid ratio strain.

Conclusion

Researchers found participants complete a higher number of responses, reaching a higher PR breakpoint, in response to an HP stimulus than an LP stimulus (Call et al., 2012; DeLeon et al., 2009; Francisco et al., 2008; Glover et al., 2008; Penrod et al., 2008). In the analysis of a concurrent schedule, the HP stimulus maintained high response rates and the LP stimulus received low to zero responses towards the task. However, when Francisco et al. (2008) examined the LP stimulus in a single- schedule arrangement the LP stimulus was able to maintain response rates from participants; this is similar to the findings of Roscoe et al. (1999). For participants in Glover et al.'s (2008) study, the LP stimulus did not receive any responding. I believe this is due largely to the LP stimulus being the lowest, or possibly zero selected, stimulus during a preference assessment. Thus, the difference of the reinforcer potency was based on the preference assessment hierarchy and values placed on each stimulus. Furthermore, the awareness of concurrent schedules being highly sensitive to different reinforcer values, and perhaps not an appropriate application in an applied setting has been suggested as a negative characteristic of the concurrent schedule (DeLeon et al., 2009). Lastly, when researchers compared two highly preferred items under a PR

schedule, one stimulus resulted in a higher cumulative number of responses and a clear correlation to the response persistence (Roane et al., 2001). The study conducted by Tiger et al. (2010) displayed the power of a participant having a choice during the condition. When providing identical stimuli, but one condition provided a choice of the stimuli from the plate rather than the experimenter handing the participant the item (i.e. no choice condition); children responded with higher rates of task completion during a geometric progressive schedule.

Discussion

The results of the review identify the clinical importance of efficiently assessing a reinforcer under an increasing schedule requirement, however researchers of the evaluated studies applied several methodological differences when examining the potency of reinforcers. The evaluation of the PR assessment exposed the methodological differences of the procedural components implemented by researchers. The different procedural elements to be discussed in this section include: (a) the introduction of the participant to the task (i.e., teaching trials; novel or mastered tasks), (b) exposure to the reinforcers (i.e., duration of access; stimuli used for reinforcement), (c) termination of the PR analyses, (d) research design, (e) preference assessment implemented, (f) evaluation of stimuli based on the preference hierarchy, and (g) step size of the PR analyses. The discussion section will be used to highlight the differing methods researchers and practitioners apply in the applied settings to determine best measures of reinforcer efficacy in my future study.

Before analyzing the results of the reinforcer assessment, I reviewed the various characteristics of each study. For instance, some researchers taught the target response with the introduction of the task (Penrod et al., 2008), used mastered skills (Roane et al., 2001), or executed teaching trials with exposure to a paired reinforcer (Call et al., 2012; DeLeon et al., 2009; Francisco

et al., 2008; Glover et al., 2008; Reed et al., 2009; Tiger et al., 2010). The duration of reinforcement provided after completion of the PR response varied. The majority of researchers provided participants with 20-s of reinforcement after completing the required task (Call et al., 2012; Glover et al., 2008; Roane et al., 2001). However, DeLeon et al. (2009) provided access to reinforcers for 30-s after task completion. Four researchers provided participants edibles (Francisco et al., 2008; Penrod et al., 2008; Reed et al., 2009; Tiger et al., 2010), so the duration of access was irrelevant. Lastly, I reviewed when the trials of response requirement were terminated due to lack of response. The termination of the PR analyses step was terminated after one minute (DeLeon et al., 2009; Reed et al., 2009), three minutes (Francisco et al., 2008; Penrod et al., 2008; Tiger et al., 2010), or five minutes (Call et al., 2012; Roane et al., 2001). The researchers' administered a variety of experimental designs, such as: a multi-element single operant design (Call et al., 2012; Reed et al., 2009; Roane et al., 2001; Tiger et al., 2010), a multi-element single operant and concurrent arrangement design (Francisco et al., 2008; Glover et al., 2008), or a multiple baseline design (Penrod et al., 2008). Concurrent schedules have been proven to be more sensitive to the differences of reinforcer value, but applied investigations of a concurrent schedule have been shown to affect the relative reinforcer effectiveness (Roscoe et al., 1999; DeLeon et al., 2009). As Glover et al. (2008) found the LP stimulus was less valuable under the concurrent schedule in comparison to the presentation in a single-operant arrangement. The LP in the single-operant assessment maintained a higher rate of response upon presentation. Therefore, the presentation of stimuli under a single- operant PR schedule may be the most applicable to the applied setting for future researchers (DeLeon et al., 2009).

Preference Assessments. Each study in the review systematically conducted a preference assessment to determine the hierarchy of stimuli. As discussed in the results section, researchers

presented several types of preference assessments. Five of the researchers solely examined a PS assessment (DeLeon et al., 2009; Francisco et al., 2008; Glover et al., 2008; Roane et al., 2001; Tiger et al., 2010), while three researchers included additional assessments. The other assessments implemented were SS, MSWO, and free-operant assessments (Call et al., 2012; Penrod et al., 2008; Reed et al., 2008). In comparing a PS assessment with a daily MSWO, the results of the reinforcer assessment suggested the PS provided a reliable identification of the most potent reinforcers and the reinforcer efficacy across the hierarchy of preferences through the initial analysis. A PS assessment identified the stimulus that resulted in the highest break points for seven of seven participants relative to the daily MSWO resulting in high break points for three of seven participants (Call et al., 2012). A comparison of two preference assessments administered in Penrod and colleagues (2008) study, identified the SS as a valuable assessment for identifying effective reinforcers under low schedule requirements. However, the researchers found it necessary to conduct a PS assessment for reinforcers assessed under higher effort requirements. Lastly, three preference assessments: SS, PS, and FO, were found to be relatively reliable with an outcome of various preferences across the three assessments; although the stimuli classified as low- and high- were identified by each of the assessments. In regard to a study conducted by Reed et al. (2009), the PS was only examined once in comparison to three examinations for the SS and FO assessments. Thus, the validity of the assessments is difficult to assess. The hierarchy of preferred stimuli determined by the implementation of a PS assessment was evaluated by single- and concurrent- schedules of reinforcement; the results of the evaluation identified the effectiveness of a PS assessment. In support of the reviewed articles, Fisher et al. (1992) and Piazza, Hanley, and Fisher (1996) reported a PS assessment had been found to have a high predictive

validity. The negative aspect of the evaluation is the amount of time it takes to administer in comparison to other assessments (see Hagopian et al., 2004, p. 672).

For professionals and clinicians, it is the utmost importance to administer an assessment to identify the most efficient reinforces promptly. The majority of the studies evaluated the identification through the evaluation of PS (DeLeon et al., 2009; Francisco et al., 2008; Glover et al., 2008; Penrod et al., 2008; Tiger et al., 2010). However, during a reinforcer assessment, DeLeon et al. (2001) found participants chose the highest ranked item from an MSWO preference assessment rather than a PS preference assessment. Further evaluation is needed in the applied literature to determine the appropriate preference assessment to determine the reinforcer potency of stimuli implemented in a high-effort PR schedule.

Evaluation of Stimuli Hierarchy. As discussed in the results section, researchers assess preference of stimuli through preference assessments; practitioners and researchers administer different preference assessments due to participant characteristics, time constraints, or type of stimuli being assessed. In 1999, Roscoe et al. produced the results that six out of seven participants responded to LP stimuli under a single-operant arrangement at rates as high as HP stimuli under a concurrent schedule. The stimuli in the arrangements were assessed through two preference assessments: SS method and PS method. The results of the two methods identified stimuli that were selected 75% or more during both the SS and PS preference assessment as HP. Stimuli that were selected 100% of trials during the SS assessment and less than 25% of trials during the PS assessment were identified as LP. In the current review, five of the eight articles identified a hierarchy of stimuli through different parameters of ranking (DeLeon et al., 2009; Francisco et al., 2008; Glover et al., 2008; Penrod et al., 2008; Roane et al., 2001). Stimuli selected at least 80% of trails in a PS preference assessment (Francisco et al., 2008; Glover et al., 2008) and 80% or higher

during SS and PS preference assessment were identified as HP stimuli (Penrod et al., 2008). As a researcher, my overall concern is the differences found in the comparison of LP stimuli. Using the same preference assessment procedure (i.e., PS), Francisco et al. (2008) identified LP stimuli as items approached 22% of trials; Glover et al. (2008) identified stimuli chosen on fewer than 25% of trials or never selected during the preference assessment as LP stimuli (Roscoe et al., 1999). Thus, when a general finding states that LP stimuli are or are not effective reinforcers, it may be related to the varying percentages that are related to the label of LP. Furthermore Penrod et al.'s (2008) identification of an LP stimulus as stimuli selected more than 80% of trials in an SS assessment but less than 40% of trials during a PS preference assessment. The effects of classifying items based on the percentage of trials selected and the classification assigned based on the percentage are examined below.

In Glover et al. (2008) the findings suggested that LP stimuli were not as effective as HP stimuli at supporting response allocation under PR schedules. In comparison, the findings of Francisco et al. (2008) and Penrod et al. (2008) found LP stimuli functioned as effective reinforcers under PR schedules. Specifically, LP stimuli selected 22% of trials (Francisco et al., 2008) and 40% of trials (Penrod et al., 2008) are more likely to be effective reinforcers in their respective studies-- in comparison to LP stimuli never selected (e.g., 0%) during a preference assessment (Glover et al., 2008). In conclusion, the discrepancy in findings that LP stimuli are effective reinforcers under PR schedules (Francisco et al., 2008; Penrod et al., 2008; Roscoe et al., 1999) and LP stimuli are not effective reinforcers under PR schedules (Glover et al., 2008) may be two folded. One, the disparity of findings for LP stimuli may correlate to offering the reinforcer not selected during the preference assessment (Glover et al., 2009) or a discrepancy in the label applied to the stimulus based upon the percentage of selection.

Similarly focusing on the HP stimuli, Roane et al. (2001) used two stimuli selected between 50-90% of trials as an HP item. In comparison, an item selected 40% of trials was identified as an LP item in the study of Penrod et al. (2008), and furthermore the same percentage was labeled as an MP item in the study of DeLeon et al. (2009). The broad range of percentages and unsystematic classification of HP, MP, and LP stimuli throughout research articles provides little analysis in the value of high and low preferred stimuli between applied studies. The current procedure of broadly identifying stimuli in their individual studies makes the general comparison of studies, and stimuli presented in PR schedules, difficult. The implementation of stimuli rankings (i.e., LP, MP, HP) should be conducted in a methodological manner based on a predetermined, systematic range (i.e., percentage). Currently, it is necessary to compare the methodological differences of the preference assessment results and the categorization of the stimuli to draw a satisfactory conclusion of LP, MP, and HP stimuli in articles.

Reinforcer Assessment. After completing a preference assessment, researchers conduct a reinforcer assessment to assess the reinforcer efficacy empirically. A reinforcer assessment tests the effort a person will put forth for a stimulus or how much a person values a stimulus identified during a preference assessment. Simply stated, the reinforcer assessment tests if highly preferred stimuli would produce faster responses or task completion among leaner schedules than lower preferred stimuli (Hagopian et al., 2004).

The benefit of PR schedules are the relative reinforcement effects are quickly identified by comparing the breakpoint for each stimulus (Hodus, 1961), as well as, providing a more accurate result for stimuli that will function as reinforcers under increasing response requirements (Roane et al., 2001). Current studies in the applied setting have implemented an additive or geometric step size. However, several researchers have used a step size incompatible to those two categories

(Reed et al., 2009; Roane et al., 2001) to increase the response requirement. Furthermore, many researchers have investigated a variety of PR step-size requirements with exposure to the schedule value once, twice, or three times before the schedule progressed (Roane et al., 2001; Roane et al., 2005; DeLeon et al. 2000). For example, the progressive ratio arrangement of PR1, PR1, PR2, PR2, has a response requirement exposure of two. Killeen, Posadas-Sanchez, Johansen, and Thrailkill (2009) discussed the arrangement of the response requirement exposure; the successive response requirement of a PR schedule has been illustrated as a basis x PR schedule in which the x is the number of exposures of the response requirement arrangement. For instance, a ratio requirement increasing by one with two exposures (e.g., PR1, PR1, PR2, PR2) is expressed as Basis 2 PR 1 (Jarmolowicz & Lattal, 2010). In the 2001 article by Roane et al., the results suggested low significance due to a decreased response pattern to the rapid PR algorithm (i.e., one exposure to the schedule requirement: PR1, PR2, PR3). A possible factor was the cause of ratio strain due to thinning the PR schedule too quickly.

Future Research

The lack of systematic application of PR algorithms, as well as the varying methodological applications, was discussed throughout this section. My suggestion for future research is to determine procedural guidelines for PR schedules in the applied setting and explore the effectiveness of PR algorithms across other reinforcer dimensions, tasks, settings, and individuals. Researchers (Roane et al., 2001; Roane et al., 2008; Tiger et al., 2010) suggested future researchers should conduct an examination of the most efficient PR algorithms and practices to develop a scientific, procedural manipulation for PR algorithms. Similarly, it would be beneficial to examine the extent to which the preference rankings of stimuli correlate to the breakpoints across the presentation and algorithm of PR schedules (Glover et al., 2008). Once the effectiveness of

preferred stimuli has been assessed through a reinforcer assessment, my suggestion is to assess the practical procedures and PR algorithms for behavioral interventions in the applied setting to increase socially mediated behaviors. The recommendation of future research from Francisco et al. (2008) was to extend the literature on reinforcer potency of stimuli along the hierarchy instead of the focus of HP and LP stimuli. This recommendation of reviewing the hierarchy of stimuli entirely is similar to the study conducted by Reed et al. (2009) in the current literature review.

Summary and Purpose Statement

The analysis of past research on PR schedules in the applied setting is limited (Roane et al., 2008). Given the methodological differences of previous studies limiting the ability to generalize the results of PR schedules to applied settings, a focus on the development and design of the methods implemented is critical. There are several inconsistencies in the implementation of PR schedules. Such as, the PR algorithm (i.e., additive, geometric, exposure to schedule requirement); implication of different percentage values for stimuli labeled as HP, MP, or LP; the duration of reinforcement provided after task completion; the forced teaching trials; research design; termination criteria for trials; and data collection. Based on my analysis of the literature, and findings by Roane et al. (2008), these inconsistencies are influencing the ability to generalize findings of previous studies. Therefore, the need of additional research on PR schedule algorithms and the percentage of stimuli labeled as HP, MP, and LP is valid.

The purpose of the current study is to extend the findings of DeLeon et al. (2009), Roane et al. (2001), Penrod et al. (2008), and Glover et al. (2008). The study by DeLeon and colleagues (2009) investigated if stimuli along the hierarchy of preferences would correspond to different breakpoints under PR schedules. The stimuli were classified as HP (i.e., items 1-4), MP (i.e., items 5-8), and LP (i.e., items 9-12). Once the stimuli were placed into the categories, DeLeon and

colleagues selected the stimuli from each preference level. The examination of stimuli occurred for four participants (ages 9-20) under an arithmetic progression PR schedule. Regarding the research design, the relationship between the preference hierarchy and PR schedule was not analyzed in a baseline phase. The extension of DeLeon et al. (2009) will analyze the differing quality of stimuli along the preference hierarchy with a baseline phase before the intervention of the PR schedule. Specifically, the future study will categorize stimuli as HP, MP, and LP from an array of six through a multiple stimulus without replacement preference assessment. In an aim to correlate and extend to previous research, the stimuli implemented in the reinforcer assessment will match previously applied percentages of stimuli. Such as the stimulus selected for the HP reinforcer assessment was approximately selected 50-90% of trials to be classified as the HP stimulus (Roane et al., 2001). The HP stimuli used in the reinforcer assessment was the highest ranked stimuli from the array. The item selected third in the preference assessment, was selected approximately 35% of trials, and labeled as the MP stimulus. Lastly, the item marked as LP was at least selected 22% of trials (Francisco et al., 2008), and the fifth selected stimuli in the preference assessment.

Furthermore, to address the lack of PR algorithm schedules consistently applied across the preference hierarchy, two PR schedule algorithms will be assessed within the reinforcer assessment. The present study aims to investigate an additive PR schedule and geometric PR schedule with data analyses that are consistent with previous studies. The remaining chapters outline the method and procedures implemented, results, and discussion of the study.

Chapter Three: Methodology

The purpose of the current study was to investigate a hierarchy of stimuli under two different PR algorithm schedules in the applied setting. This chapter introduces the methods for the study. The participants, setting, and materials are presented first; followed by the experimental design and measurements, and the dependent variables. Lastly, the procedures for the preference assessment, reinforcer assessments, interobserver agreement, and fidelity are discussed.

Participants and Settings

Three individuals, all males, ranging between the ages of 16 years old and 28 years old participated in the study. Participants were recruited through a local services provider and a flyer with the local Autism Society Chapter. In order for a participant to be eligible for the study (a) a legal guardian provided permission to participate in the study, (b) a task was able to be completed while sitting at a table, (c) able to perform choice making actions, and (d) have stable preferences based on indirect assessments (e.g., parent or caregiver report). A fourth participant was initially selected for the study. He was deemed unqualified due to inability to perform choice making actions and lack of six preferences.

Michael was a 28-year-old Caucasian man with confirmed ASD, significant intellectual disability, and an epilepsy diagnosis since the age of three. He graduated from a Life Skills program at the age of 21. He receives 1:1 support, 12 hours a day, to assist with daily living and self-care skills, job trials, and leisure activities. He has limited expressive language and uses an AC device to further his communication and requests. He displays some minor aggression and escape behavior. Michael would be considered a level three under the DSM-5. He lives in a renovated basement apartment of his parents' home, which is where the assessments took place.

He has a job at a local gym. The items in the preference assessment were selected by his mother and a support provider.

Willie is a 26-year-old Caucasian male with a genetic diagnosis of Fragile X syndrome and ASD. He graduated from an 18-22 transition program. He lives with a roommate in a duplex with personal attendant care present around the clock. The support staff aid on self-care skills, independent living skills, and leisure and athletic skills. He holds a job trial through his parent's work. Willie communicates using short sentences to express his wants or engage socially; he has a higher receptive understanding than expressive. Willie displays more anxiety driven behaviors; he has very little aggression and will show frustration by vocal stims. Willie would be considered a level three under the DSM- 5. The items present in the preference assessment were selected by his mother and a support provider. The assessments took place at a table in a work room.

Evan is a 16-year-old Caucasian male. He was beginning a life skills program at his high school this year. Evan had a confirmed diagnosis of ASD. He lived at home with his parents. He received little physical aid from his parents in the daily self-care skills. He was able to communicate in short verbal sentences, and receptively understand directions. According to the DSM-5, Evan would likely be considered a person with needs similar to a level one. Evan had several anxiety-driven behaviors surrounding his schedule, but no other challenging behaviors. The items presented in the preference assessment were selected by his mother. The assessments took place at his family dining table.

Materials

Materials for the researcher included a stop watch, iPad, and data sheets. The materials for the participants included the stimuli chosen for the reinforcer assessments and the materials needed for each participants' task. The work materials for Evan were: a wood silverware tray with four

sections, sixteen cloth napkins, plastic spoons, knives, and forks. The work materials used Willie were: a wood silverware tray with four sections, pre-folded paper napkins, and the same plastic silverware. The materials used in Michael's task was the wood silverware tray and plastic spoons and forks.

Experimental Design and Conditions

An alternating treatment design was conducted to assess the stimuli (e.g., HP, MP, LP) under two progressive ratio schedules during the reinforcer assessment. The two PR schedules were an additive schedule and a geometric schedule. During the reinforcer assessments, the maximum repeating condition of the schedule was two (i.e., the additive or geometric schedules repeated no more than two times for the stimuli being assessed), and the PR schedule was randomized. The reinforcer assessments for the two PR schedules were counterbalanced in a within-subjects design.

Three assessment packages were created to counterbalance and randomize the order of the conditions. Each participant received the reinforcer assessments in a different order. Such as, Evan received the HP, MP, and then LP order of conditions. The second participant, Michael, received the MP, LP, and HP order of conditions. Willie received the order of LP, HP, and MP conditions. Within the order of conditions, the PR schedules were counterbalanced. For the first participant, the HP condition began with the geometric schedule, the second participant it began with the additive schedule, and for the third participant it began with the geometric. For the MP condition, the first participant began with the additive schedule, the second participant began with the geometric schedule, and the third participant began with the additive schedule. Lastly, for the LP condition, the first participant began with the geometric schedule, the second participant began with the additive schedule, and the third participant began with the geometric schedule.

A trial was considered terminated when: two minutes with no response, 30 seconds away from the table of work, or the participant requested to end the trial (e.g., "stop"). All baseline conditions were 5 minutes with no reinforcement provided. The reinforcer assessments had a maximum session time of 20 minutes with 20 seconds of a reinforcer break when the schedule requirement was met. The reinforcer conditions were continued until a stable data path of two or more data points was observed for the breakpoint or responses per minute for either PR schedule. No more than 3-6 trials were conducted in one session, and the researcher met with the participants 3-5 days a week.

Preference Assessment

A multiple-stimulus without replacement (MSWO) preference assessment was implemented based on procedures by DeLeon and Iwata (1996) to identify the HP, MP, and LP items. An indirect assessment was conducted to collect the items used in the assessment. A total of six stimuli based on the indirect assessment were implemented in the formal assessment. The six stimuli were placed in front of the participant with equal distance between the stimulus. The experimenter prompted the participant to select an item (i.e., "pick one"). If the participant approached an item, the other stimulus were removed to allow for 20-s access to the selected item. Attempts to approach more than one stimulus were blocked with the SD simultaneously restated (e.g., "pick one"). The hierarchy of stimuli were analyzed by dividing the number of trials that each item was approached by the number of trials that it was presented, multiplied by 100 to determine the percentage. Based on the percentage, the stimuli were ranked as HP, MP, and LP. The experimenter did not use the item selected the least or zero times during the preference assessment to increase the probability that the LP item has reinforcer potency (Francisco et al., 2008).

Reinforcer Assessment

An examination of the reinforcing efficacy of the HP, MP, and LP items were compared. The examination was adapted from DeLeon et al.'s (2009) procedures that were procedurally similar to Piazza, Fisher, Hagopian, Bowman, and Toole (1996). Two progressive-ratio reinforcer schedules were administered to examine the stimuli in a reinforcer assessment. Therefore, the schedules were compared during a reinforcer assessment for each stimulus. One PR schedule assessed the effects of an additive algorithm (e.g., PR1, PR2, PR3, PR4), and the second PR schedule examined the effects of a geometric algorithm (e.g., PR1, PR2, PR4, PR8, PR16). Identical tasks were used for both progressive-ratio schedules (e.g., additive and geometric) across the reinforcer assessments for each stimulus (e.g., HP, MP, LP).

Teaching Protocol. A pre-experimental training was conducted with each participant following a prompting hierarchy. A three-step teaching protocol was followed: (1) a model and a most to least prompt, (2) model with least to most prompt, and then an independent trial (e.g., "Let me see you do it"; "your turn"). Each participant had a different target response based on the difficulty of the task. All three participants had previously experienced similar tasks to the ones they were provided. Multiple tasks were probed for Evan; initially the task was to complete dollar amounts from an assortment of coins. However, the task was deemed too difficult once tested.

For the two participants who had multi- step tasks, the tasks were taught separately. For example, Evan who first folded a napkin then placed the silverware, successfully folded the napkin in the training session prior to progressing to the next step. After successfully responding the participant received verbal praise (e.g., "nice job"). The second step of the multi-step task followed the same training protocol. Once successfully completing the second step, the researcher modeled the complete task while stating, "first you, then you."; the training protocol was completed again

for the entire task. After successful completion the task was considered mastered and the participant began the baseline condition.

Procedures

Baseline. All materials required to engage in the target response were present. For Evan, the materials present were the silverware tray, napkins, and silverware. For Willie, the present materials were: the silverware tray, pre-folded napkins, and silverware. For Michael the materials were: the silverware tray, and fork and spoons. No programmed contingencies were introduced during baseline. The experimenter instructed the participant to do the task (i.e., "You are going to do {task}, you can do as much as you want"). All baseline sessions were 5 minutes in duration unless (1) the participant stated he was done, (2) 2 minutes elapsed without a response, or (3) the participant eloped for more than 30-s. Sessions were conducted until a stable data path was present.

Progressive-ratio reinforcer assessments. The task materials for each participant and the intended reinforcer for the assessment (e.g., HP, MP, LP) were present on the table prior to beginning the session. Prior to each reinforcer session, the experimenter held up the stimulus under examination and stated, "If you want your (e.g., stimulus available), you have to finish your (e.g., task)" and modeled the task. The target response was completed with most to least guidance as conducted by Glover et al. (2008). After the target response was completed the participant received 20-s access to the stimulus in the condition. The researcher retrieved the stimulus and placed it on the table in front of the participant. The subsequent session began the experiment, and the PR schedule, which was introduced with a verbal prompt (e.g., "first task"); no verbal prompts were provided after the initial introduction of the schedule. The available stimulus remained within view of the participant at all times. Upon accurate task completion, thus meeting the schedule requirement, the participant received the reinforcer for 20-s.

Session time began as the experimenter delivered the task while stating "first task" and ended when the participant reached the breakpoint criterion or termination of the trial. The end of the session was demonstrated when the experimenter placed their hand on the task materials to be removed, while simultaneously providing the reinforcer. After 20-s of reinforcement, the reinforcement period had elapsed; this was prompted by the removal of the reinforcer through a verbal prompt (e.g., "my turn"). The next trial was presented by returning the silverware tray in front of the participant. The session time began when the experimenter's hand was removed. Sessions continued until the participant's responding subsided for two minutes, the maximum session time of twenty minutes was reached, or the participant asked to stop the trial. The reinforcer assessments followed the order based on the condition package the participant received.

Additive Schedule. The procedures for the assessment were stated above. The PR schedule increased in an arithmetic progression (e.g., PR1, PR2, PR3) until the trials were discontinued for the stated reasons.

Geometric Schedule. The same procedures, tasks, and stimuli were implemented as the PR additive condition. However, the PR schedule increase by a geometric step size by two (e.g., PR1, PR2, PR4, PR8, PR16, PR32).

Tasks

Evan. The task implemented for Evan was a multi-step task that would be appropriate in a job setting. To successfully complete a task, he picked up a cloth napkin from a four-slot silverware tray and double- folded the napkin. Before placing the silverware, the napkin was folded with touching corners. If the napkin was not properly folded it was incorrect. After completing the fold, he picked up a fork, knife, and spoon from the silverware tray and placed it on the napkin. The

silverware could be picked up in any order. Once the silverware was placed on the napkin it was counted as correct.

Michael. The task administered for Michael was a sorting task. The silverware tray used for the other participants was reduced to two slots. The first slot was for forks and the second for spoons. One utensil was kept in each slot to identify the correct location to sort the silverware. Michael only sorted two utensils, fork and spoon. The silverware was presented in a counterbalanced manner; each session, the silverware was presented in the reverse order relative to the last session. If Michael attempted to pick up more than one silverware to sort, even if sorted correctly, the trial was terminated. Since it was a mastered task, and sorting errors often occurred in the applied setting, it was incorrect.

Willie. The task presented to Willie was to place silverware on a pre-folded napkin. When probing the task, Willie was unable to successfully complete the multi-step task of folding the napkin prior to placing the silverware. His task incorporated the same silverware tray with four slots. The first slot had the pre-folded napkins, then the silverware in each separate slot. The task was to pick up a napkin, and in any order, place all three utensils on the napkin. The trial was terminated if two of the same utensils were placed on a napkin.

Dependent Variables and Measurement

During the multiple-stimulus without replacement (MSWO) preference assessment, the dependent variable was the order of stimuli selected. A selection was based on an approach response defined by a participant either touching or picking up the stimulus (Francisco et al., 2008). The preference hierarchy of stimuli was developed based on the order of selection. The HP stimulus was selected most often, the MP stimulus was the third chosen item, and the LP stimulus was the fifth selected item. Only the stimulus being assessed in the reinforcer assessment was

present when conducting the study. Data was collected for three dependent variables in the reinforcer assessments: response per minute (rpm), breakpoint (BP), and the cumulative number of responses. Further analysis of the data provided the: mean rpm, mean BP, mean cumulative number of responses, number of terminated trials, and percentage of total tasks correct.

The effects of the progressive ratio schedules on the HP, MP, and LP stimuli were analyzed for each participant. A response rate for each trial was calculated by dividing the total number of responses by the session duration (in minutes) to produce the number of responses per minute (rpm) (Penrod et al., 2008). By adding the rpm of each schedule in the reinforcer assessment then dividing the value by the total number of sessions the mean rpm was obtained. The breakpoint of each stimulus was the last schedule requirement completed in a trial. The average breakpoint was calculated by adding the breakpoint across the stimuli sessions then diving by the total number of sessions in that condition. In addition, adding the total number of responses per session yielded the cumulative number of responses across the reinforcer assessment conditions. The slopes were then graphed to provide an analysis of the response pattern under the two PR schedules.

The calculation of the total tasks correct was yielded by adding the total tasks completed under the stimulus for each schedule, divided by the total number of possible tasks to be completed for each session. For instance, Michael completed 87 tasks during the additive schedule in the MP reinforcer assessment. Although, had he completed the tasks of each trial begun (i.e., not terminated or errored during the trial), then he would have completed a total of 120 tasks. Therefore, by diving the total tasks correct (n= 87) by the total possible tasks to be completed (n= 120) and then multiplying by 100, the percentage of total tasks correct was obtained (n= 73%). If the maximum session time of 20 minutes was reached, the remaining tasks in the trial were not counted in the total number of possible tasks to be completed. Further, if the participant chose to stop the

trial, errored, or NR of two minutes the remaining tasks in the trial were counted as possible tasks to be completed.

Lastly, the terminated sessions were recorded. The purpose was to understand the general effects and acceptance of the increasing schedule by the participants. Termination of the session was observed as two minutes of no response or asking to stop the trial. No participants left the work table for more than 30-s. The total session duration did include the two minutes of no response. However, the reinforcer access time was not included in the session duration.

Interobserver Agreement

Interobserver agreement (IOA) was collected for at least 30% of sessions for both the preference assessment and reinforcer assessment. A second trained data collector independently scored the sessions through recordings. IOA was calculated by taking the number of intervals of agreement divided by the number of intervals of disagreement, multiplied by 100. IOA for the preference assessments was 100% for all participants. IOA for Willie was calculated as: LP was 100%, MP was 98% (range 96-100%), and HP was 99% (98%-100%). The agreement for Michael was calculated as: LP was 99% (98-100%), MP was 100%, and HP was 99% (98-100%). Evan's IOA: LP was 98% (96-100%), MP was 99% (97-100%), and HP was 98% (96-100%).

Procedural Fidelity

Procedural integrity data was collected for a minimum of 30% of sessions for both the preference assessment and reinforcer assessments. The sessions were randomly selected for each participant, with at least one session from each reinforcer assessment and PR schedule. The independent observer completed the fidelity checklist for the intervention of reinforcer assessment through video-recorded sessions. The fidelity checklist indicated the steps completed in the intervention phase as "correct", "incorrect", or "n/a". The procedural fidelity was

calculated by dividing the number of steps correct by the total number of steps and given a percentage. The procedural fidelity measures were 100% for all three participants.

Chapter Four: Results

Preference Assessment

Table 1 shows the results of the MSWO for Evan. During the administration of the assessment, Evan never selected his phone. The preference order of the selections are listed in descending order of preference, including Evan's mother's iPad as HP, his mother's phone as MP, and paper and markers as LP. The results of the Michael's MSWO assessment are shown in Table 2. The order of preferences for Michael included the fish puzzle as HP, the instrument puzzle as MP, and paper and markers as LP. Table 3 shows the results of the MSWO for Willie. The order of preferences for Willie included the puzzle as HP, the photo album as MP, and the "I Spy" as LP.

Table 2
Evan's Preference Assessment- Rankings

Stimuli	1	2	3	4	5	Total	Rank
Mom's iPad	1	1	2	2	3	9	HP
Pet Pillow	2	3	1	3	1	10	
Mom's Phone	3	5	4	1	2	15	MP
Mario Game	4	2	3	5	4	18	
Markers/Paper	5	4	5	4	5	23	LP
Evan's phone	6	6	6	6	6	30	

Table 3
Michael's Preference Assessment- Rankings

Stimuli	1	2	3	4	5	Total	Rank
Fish Puzzle	2	1	1	1	1	6	HP
Speech Puzzle	1	4	2	2	4	13	
Instrument Puzzle	3	2	3	3	5	16	MP
iPad	4	3	4	4	3	19	
Markers/Paper	5	5	5	5	2	22	LP
Music	6	6	6	6	6	30	

Table 4
Willie's Preference Assessment - Rankings

Stimuli	1	2	3	4	5	Total	Rank
Fish Puzzle	4	2	1	1	1	9	HP
Locks	2	1	4	3	2	12	
Photo Album	3	3	3	2	3	14	MP
Matching Cards	1	4	2	6	4	17	
I Spy	6	5	5	4	5	25	LP
iPad	6	6	6	6	6	30	

Reinforcer Assessment

The results of the reinforcer assessments are depicted in Figures 1- 27 below. Figures 1, 2, and 3 depict the results with the HP stimuli for Evan. Figures 4, 5, and 6 display the results of the HP stimuli for Michael, and figures 7, 8, and 9 depict the results with the HP stimuli for Willie. Figures 10, 11, and 12 depict the results with the MP stimuli for Evan. Figures 13, 14, and 15 depict the results of the MP stimuli for Michael, and figures 16, 17, and 18 depict the results of the MP stimuli for Willie. Figures 19, 20, and 21 depict the results with the LP stimuli for Evan. Figures 22, 23, and 24 depict the results with the LP stimuli for Michael, and figures 25, 26, and 27 depict the results with the LP stimuli for Willie.

Baseline. Evan, Michael, and Willie all responded at zero rates during all baseline trials.

High preference (HP). Figure 1 shows responses per minute for Evan. Evan responded at a higher rate during the additive schedule (M= .54 responses per minute) than during the geometric schedule (M= .33 RPM). When responding to the additive schedule, Evan also completed more tasks (M= 90 task completions) with a correct response rate of 85% (i.e., 90/106). Figure 2 shows the breakpoint data for Evan. The highest breakpoint (i.e., the last reinforced PR requirement

completed) was observed within the geometric schedule. A breakpoint of 8 was observed twice during the geometric schedule, in comparison to reaching that same breakpoint once during the additive schedule. The average breakpoint was equal for both schedules (M= 4.2). Even though Evan demonstrated higher breakpoints during the geometric schedule, he completed a lower number of tasks (M= 50 task completion) with a correct response rate of 53% (50/94) in that condition. Evan terminated (i.e., did not respond for two minutes or chose to stop the trial) during 4 out of 6 sessions in the additive schedule and 5 out of 6 sessions in the geometric schedule. He continued to respond for the maximum session time once for both schedules. The cumulative number of tasks completed during the PR schedules are reflected in Figure 3. A steeper slope indicates an increasing response rate during the implemented schedule (i.e., Penrod et al., 2008). An immediate, steady slope was observed during the additive schedule compared to the geometric schedule with Evan.

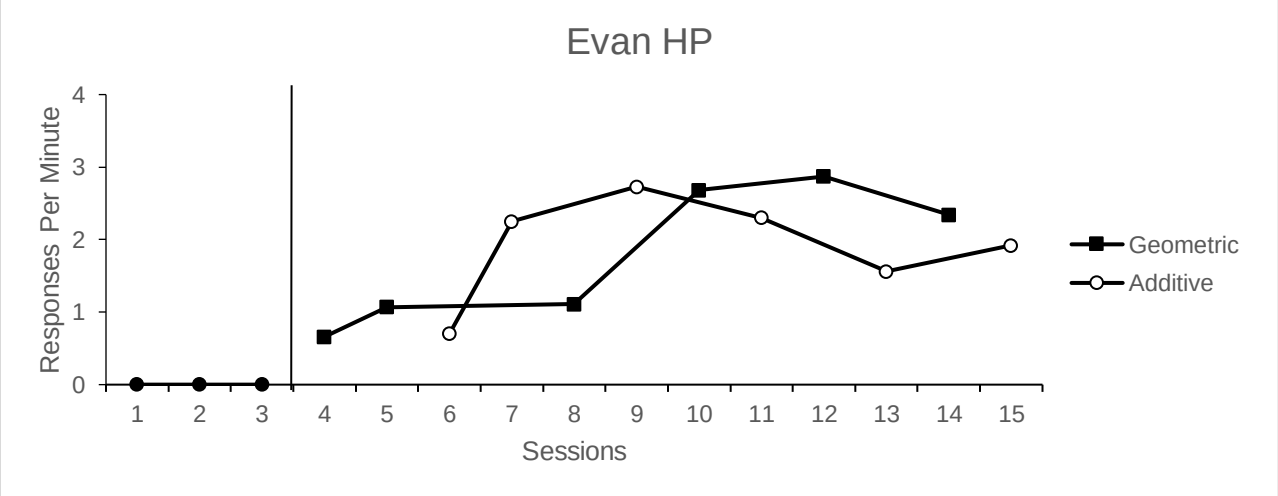

Figure 1. Results of the HP reinforcer assessment for both progressive schedules are shown. The graph depicts the response per minute (RPM) for both schedules

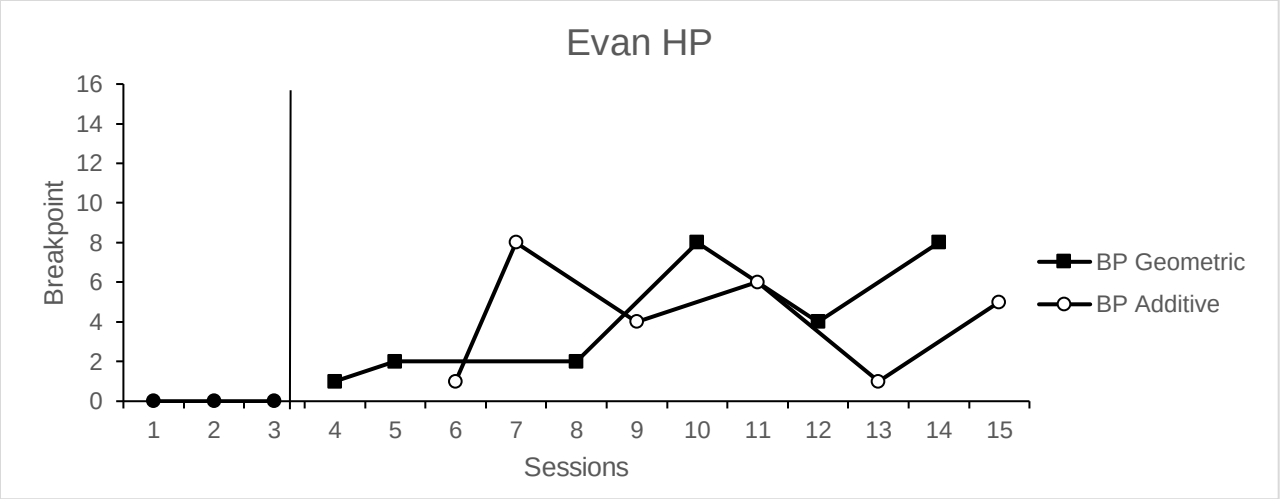

Figure 2. Results of the HP reinforcer assessment for both progressive schedules are shown. The graph depicts the breakpoint for both schedules.

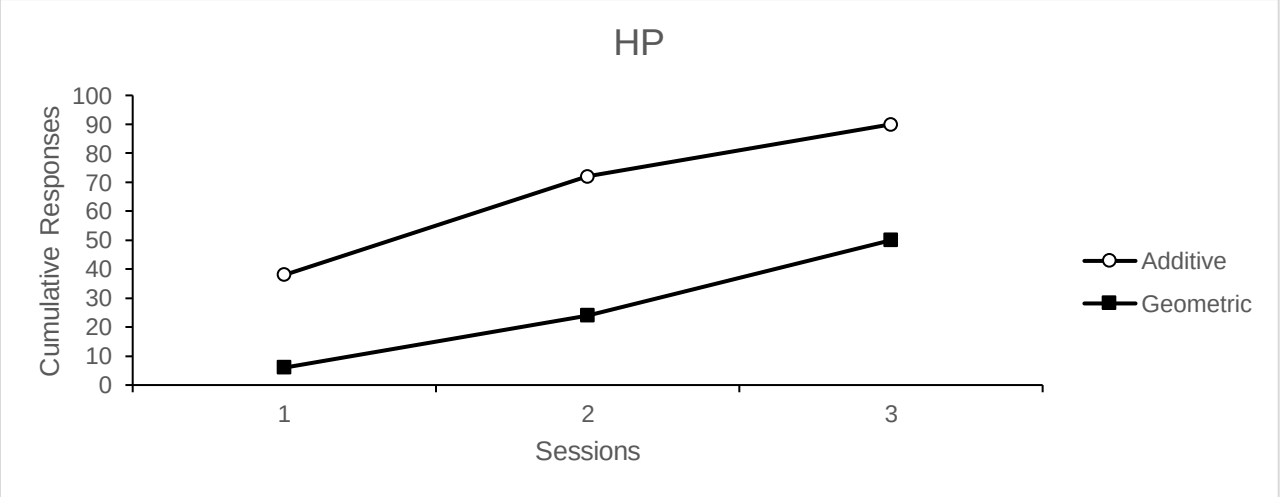

Figure 3. Results of the HP reinforcer assessment for both progressive schedules are shown. The graph depicts the cumulative number of responses for both schedules across the sessions.

Figures 4-6 display the results of the HP reinforcer in Michael's assessment. Figure 4 shows responses per minute for Michael. A higher average response per minute were observed during the additive schedule (M= 5.8), than the geometric schedule (M= 4.7). Similarly, a higher task completion was accomplished during the additive schedule (76/101) with a correct response rate of 75%. During the geometric schedule, Michael completed 51 of 77 possible tasks, reaching a correct response rate of 66%. Figure 5 shows the breakpoint data for Michael. The highest

breakpoint observed was 6, which he demonstrated during the additive schedule, with an average breakpoint of 3.9. Michael had a lower response to the geometric schedule; he reached a maximum breakpoint of 4, with an average breakpoint of 3. Michael did not terminate any sessions, nor did he work the maximum amount of time. The cumulative number of tasks completed during the PR schedules are reflected in Figure 6. Michael consistently responded during both PR schedules, but a higher, steady increase in the slope was observed during the additive schedule compared to the geometric schedule.

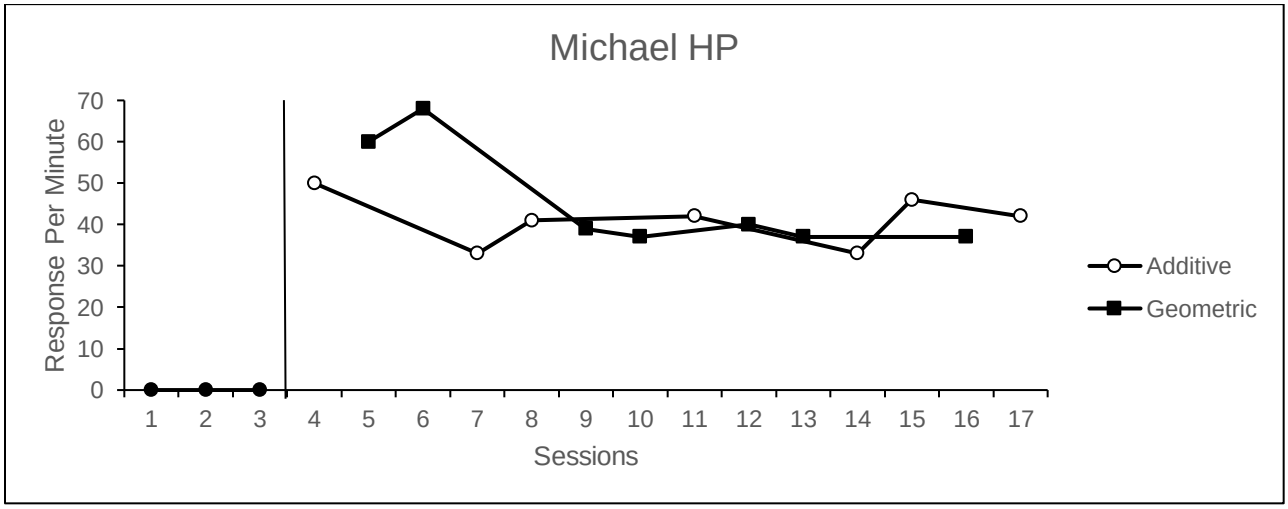

Figure 4. Results of the HP reinforcer assessment for both progressive schedules are shown. The graph depicts the response per minute (RPM) for both schedules.

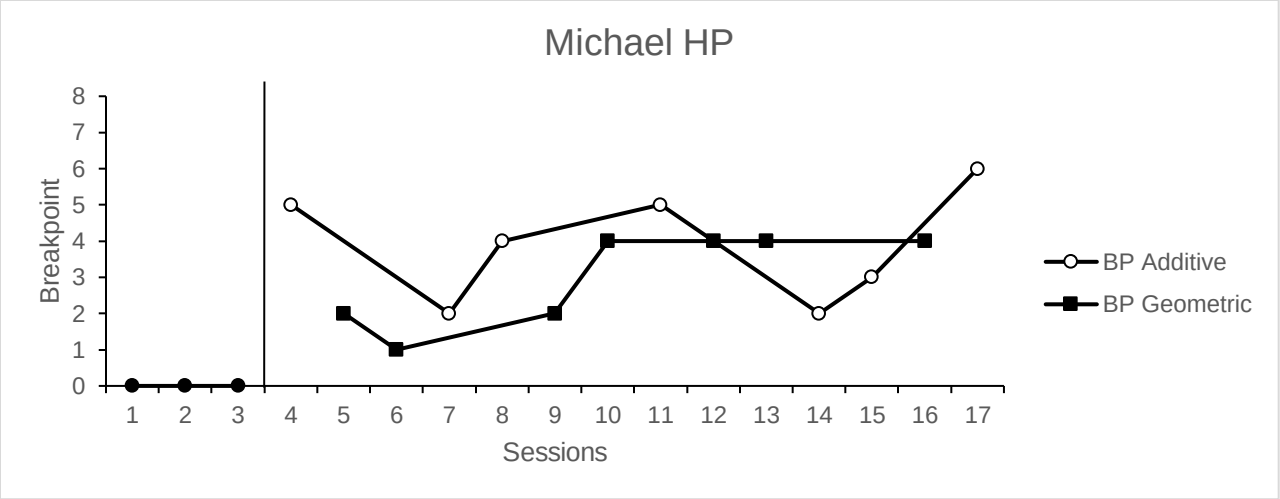

Figure 5. Results of the HP reinforcer assessment for both progressive schedules are shown. The graph depicts the breakpoint for both schedules.

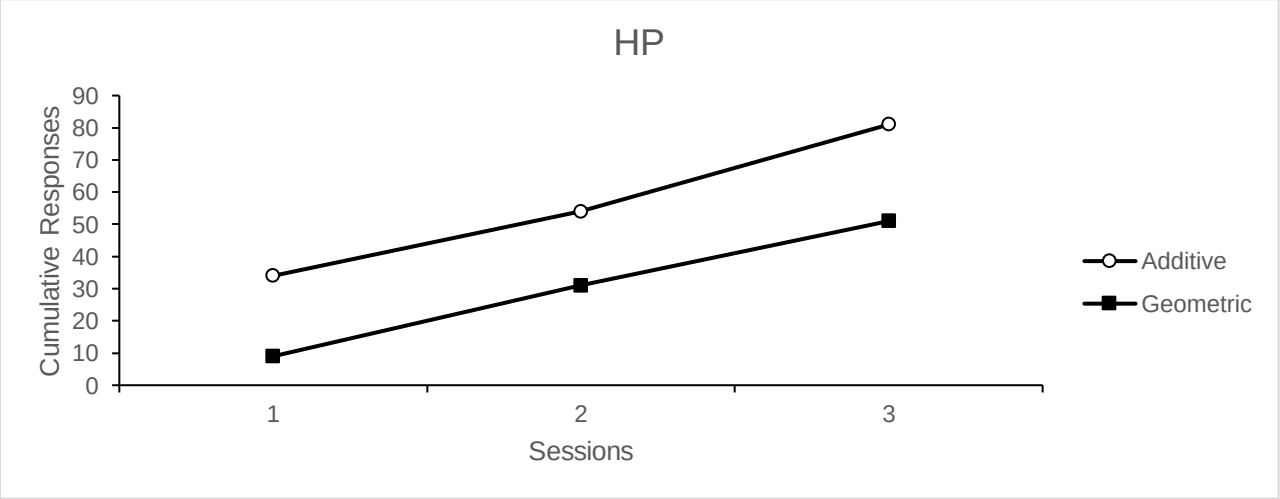

Figure 6. Results of the HP reinforcer assessment for both progressive schedules are shown. The graph depicts the cumulative number of responses for both schedules across the sessions.

Willie's responses to the high preference reinforcer are presented in Figures 7-9. Figure 7 shows responses per minute for Willie. The average response per minute (*M* = .37) was observed during the additive schedule while the average response of the geometric schedule was lower (M= .15). Higher task completion was observed during the additive schedule (M= 72) with a correct response rate of 73% (72/98). During the geometric schedule, Willie's response rate was

41% (22/54 tasks correct). Figure 8 shows the breakpoint data for Willie. The highest breakpoint demonstrated was 6 during the additive schedule, with an average breakpoint of 2.7. Willie demonstrated a breakpoint of 4 with an average breakpoint of 1.6 during the geometric schedule. Willie terminated 2 out of 10 geometric sessions and 1 out of 10 additive sessions. Figure 9 shows the cumulative number of tasks completed during the PR schedules for Willie. The slope for both schedules were increasing at a low rate, which shows breaks in the response rate during the assessment; however, the cumulative number of responses was higher during all sessions of the additive schedule. During the last session of the additive schedule a steep increase is demonstrated in the response rate and thus illustrated in the slope.

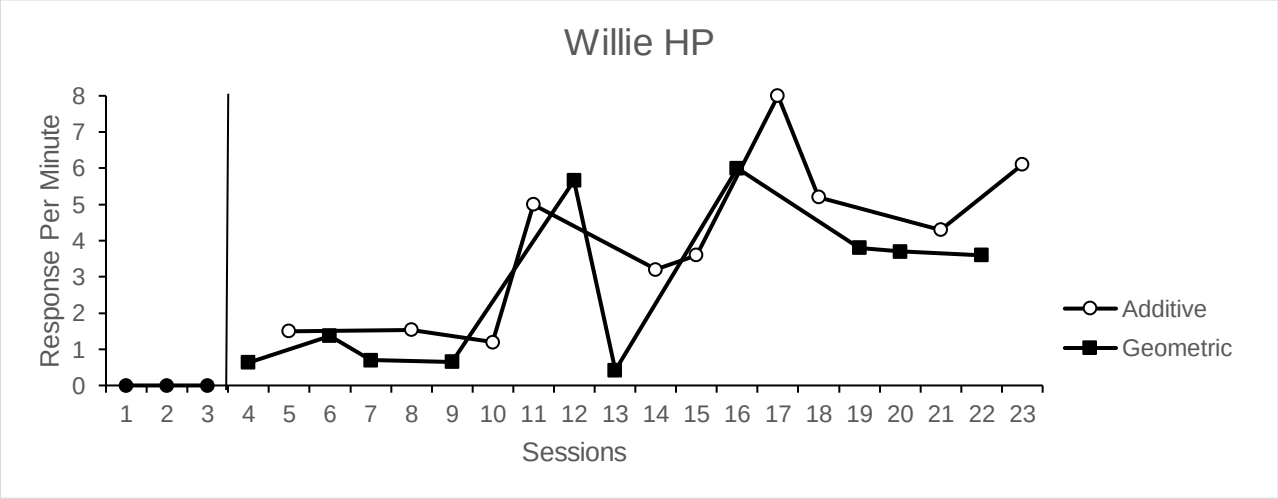

Figure 7. Results of the HP reinforcer assessment for both progressive schedules are shown. The graph depicts the response per minute (RPM) for both schedules.

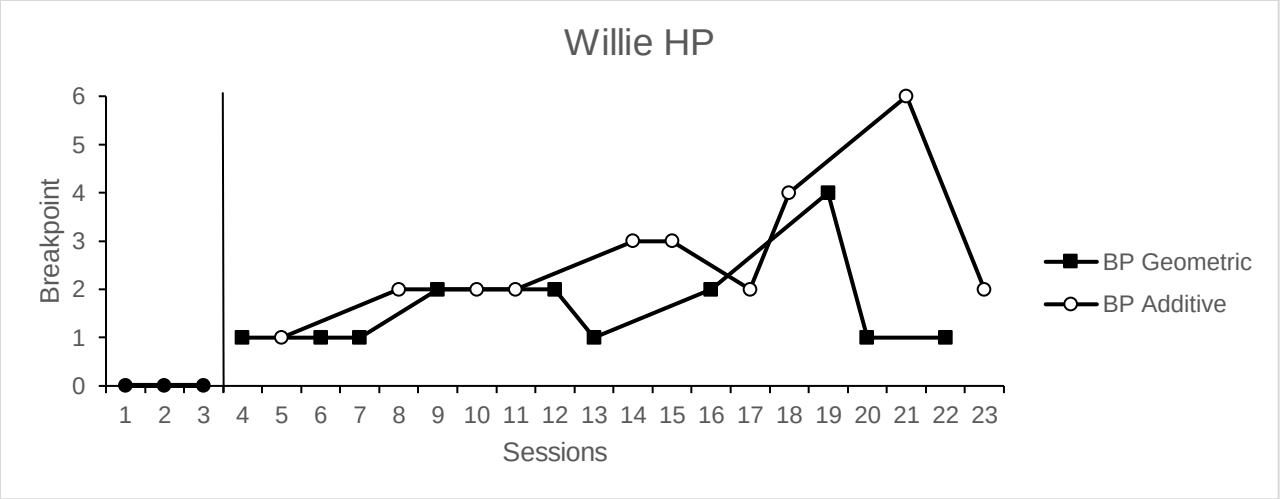

Figure 8. Results of the HP reinforcer assessment for both progressive schedules are shown. The graph depicts the breakpoint for both schedules.

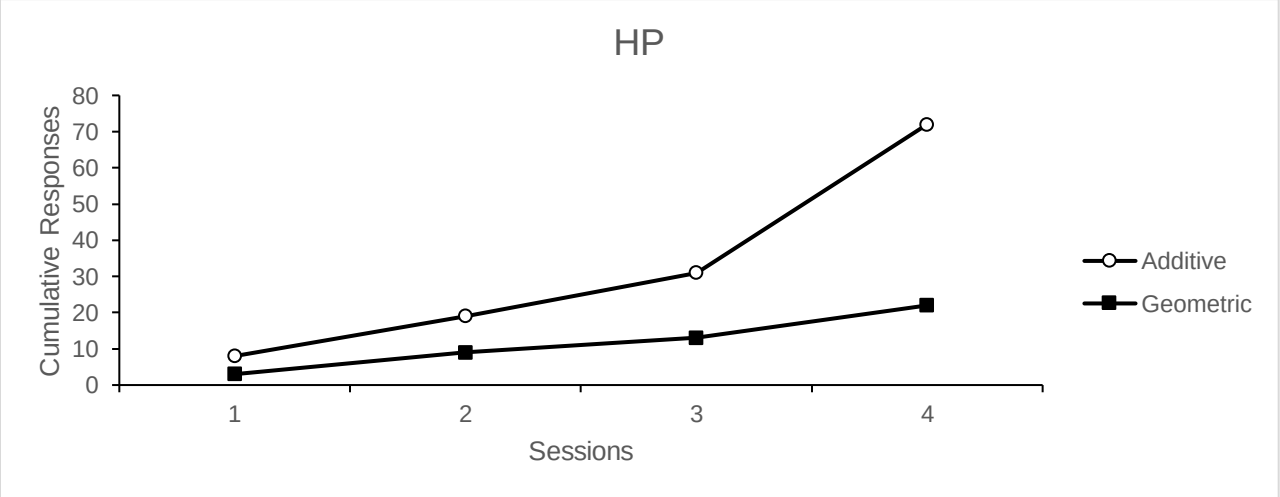

Figure 9. Results of the HP reinforcer assessment for both progressive schedules are shown. The graph depicts the cumulative number of responses for both schedules across the sessions.

Moderate preference (MP). Figures 10, 11, and 12 reflect the results of Evan's data in the MP reinforcer assessment for the PR schedules. In Figure 10 the response per minute is shown for Evan. During the additive schedule, Evan completed the work at a slightly faster rate (M= 1.58) than compared with his response rate within the geometric schedule (M=1.48). The participant errored less during the additive schedule. He completed 96/102 of the possible tasks (M= 94%) in comparison to completing 81/105 during the geometric schedule (M= 77%). Figure 11 shows the

breakpoint data for Evan. The average breakpoint for the additive and geometric schedules both equaled, M= 4.1. Evan demonstrated a higher breakpoint during the geometric schedule (M=8) than the additive schedule (M= 6). Lastly, Evan terminated 3 out of 7 sessions during the additive schedule, and 5 out of 7 sessions during the geometric schedule. In both schedules, he continued the session for the max duration once. Figure 12 illustrates the cumulative number of tasks completed during the PR schedule. An insignificant difference is illustrated in the response rate between the two schedules based on the cumulative number of responses. The additive schedule did receive more responses overall.

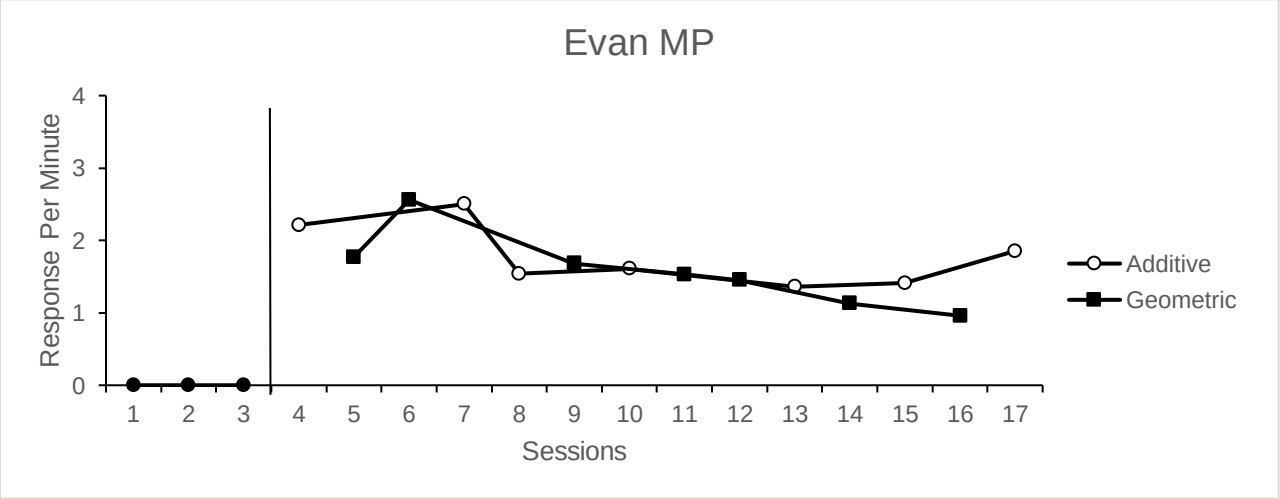

Figure 10. Results of the MP reinforcer assessment for both progressive schedules are shown. The graph depicts the response per minute (RPM) for both schedules.

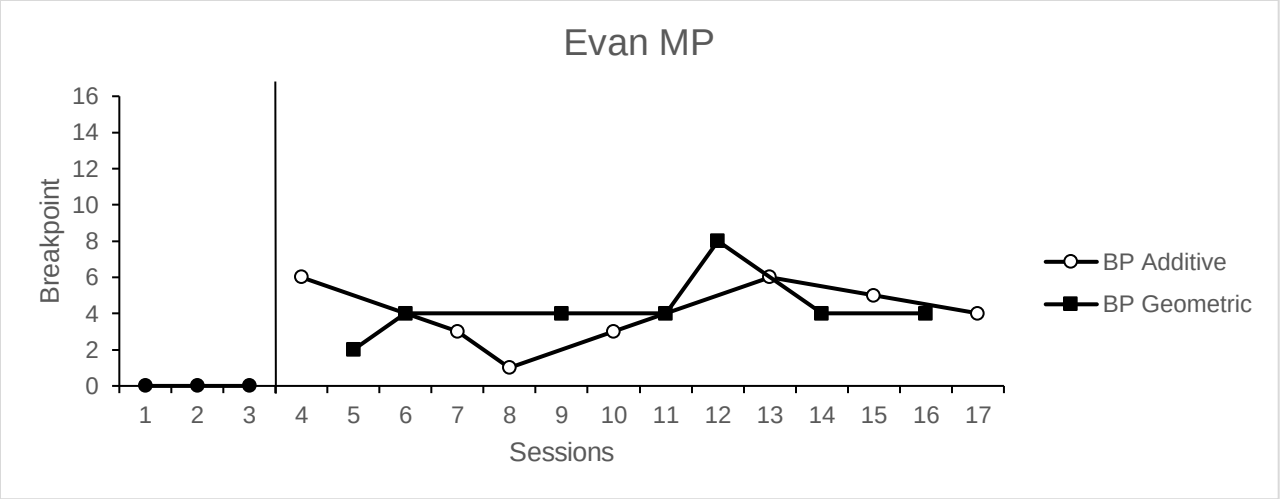

Figure 11. Results of the MP reinforcer assessment for both progressive schedules are shown. The graph depicts the breakpoint for both schedules.

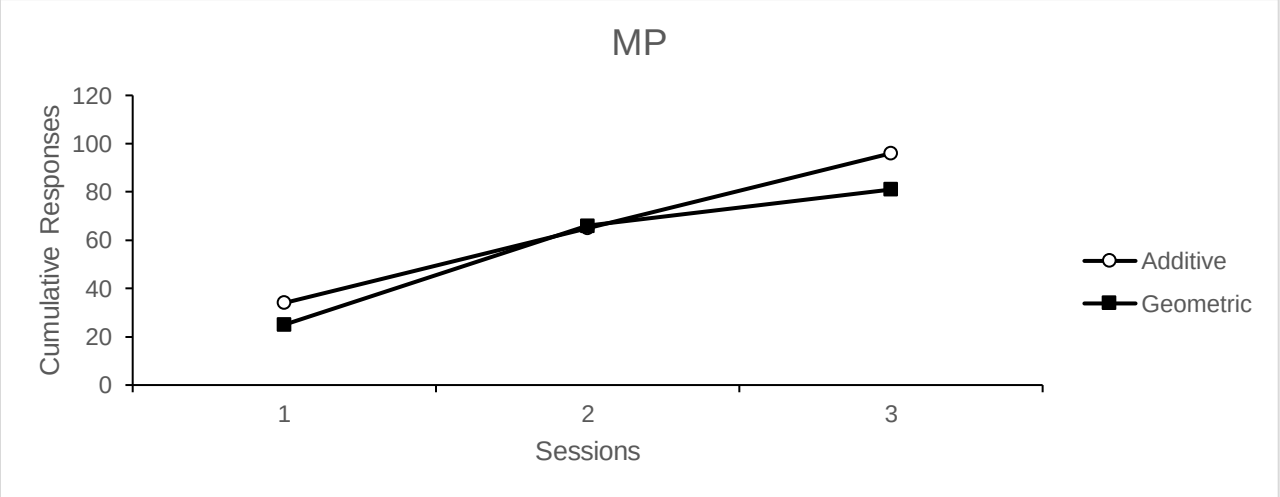

Figure 12. Results of the MP reinforcer assessment for both progressive schedules are shown. The graph depicts the cumulative number of responses for both schedules across the sessions.

The results of the MP reinforcer for Michael's assessments are shown in Figure 13-15. Figure 13 shows responses per minute for Michael during the MP assessment. He performed the tasks at a faster response per minute (M= 3.56) in the additive schedule. Michael's average response rate per minute for the geometric schedule was 2.56. A slightly higher task completion was shown during the additive schedule (87/120) with a correct response rate of 73%. Michael completed 74 of 123 possible tasks reaching a correct response rate of 60% during the geometric

schedule. Michael did not terminate any sessions, nor did he work the maximum amount of time for either schedule. Figure 14 shows the breakpoint data for Michael. The highest breakpoint of 8 was completed twice during the geometric schedule. Michael reached a lower breakpoint of 4 with the additive schedule. The outcome of the mean breakpoints were the same for both schedules (M= 3.7). The cumulative number of tasks completed during the PR schedules are reflected in Figure 15. The response rate was similar between the two schedules, though a higher number of responses occurred during the additive schedule. A higher, steady increase is illustrated in the slope of the additive schedule.

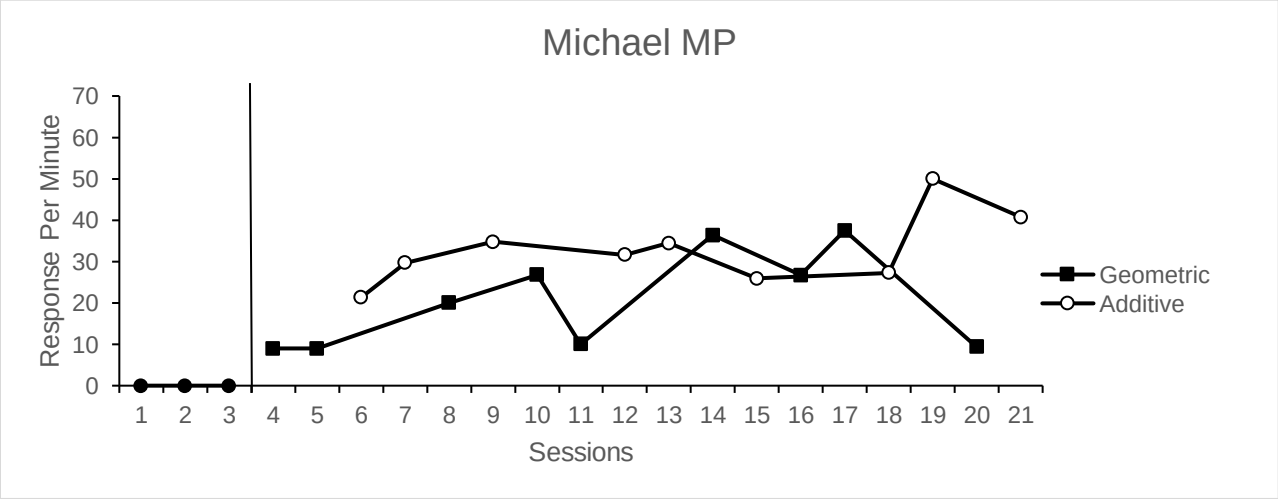

Figure 13. Results of the MP reinforcer assessment for both progressive schedules are shown. The graph depicts the response per minute (rpm) for both schedules.

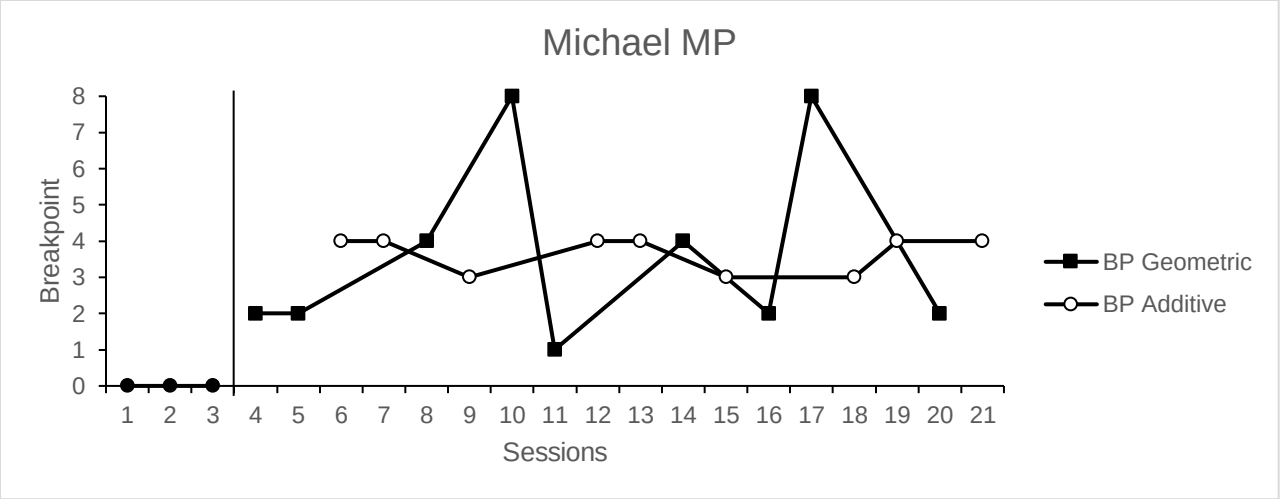

Figure 14. Results of the MP reinforcer assessment for both progressive schedules are shown. The graph depicts the breakpoint for both schedules

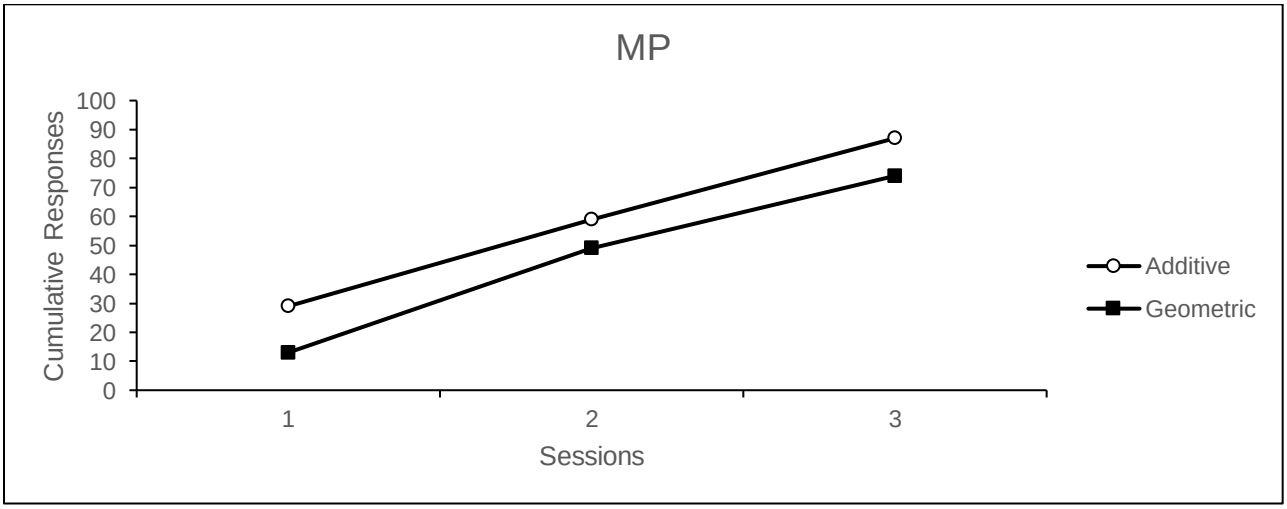

Figure 15. Results of the MP reinforcer assessment for both progressive schedules are shown. The graph depicts the cumulative number of responses for both schedules across the sessions.

The results of Figure 16, 17, and 18 illustrate the data collected during the MP reinforcer assessment. Figure 16 shows the responses per minute for Willie. His rate of task completion was faster during the geometric schedule (M= 2.1 rpm) than with the additive schedule (M= 1.8 rpm). His response accuracy on tasks associated with the MP was higher during the additive schedule

(53/87, M= 61%) than the corresponding rates during the geometric schedule (39/74, M=53%). Figure 17 shows the breakpoint data for Willie. Willie demonstrated higher breakpoint during the additive schedule (M= 5), with an overall higher average breakpoint (M= 2.5). During the geometric schedule, Willie demonstrated a breakpoint of 4 with a mean breakpoint of 2.1. Figure 18 depicts the cumulative number of tasks completed during the PR schedules. The geometric schedule received more responses during the first session however the additive schedule continued to increase at a higher rate throughout the assessment. The lines were parallel.

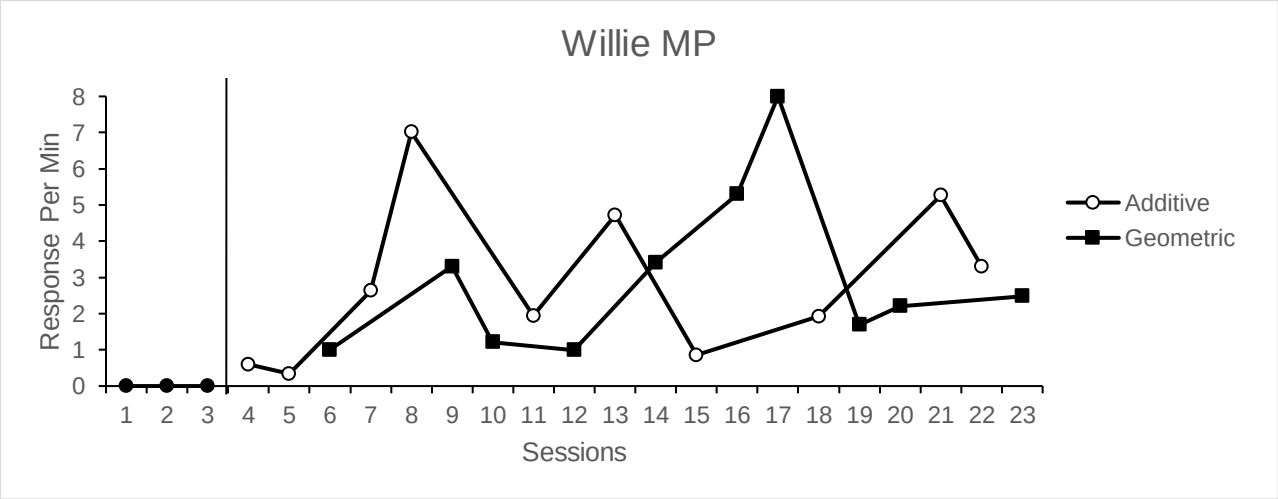

Figure 16. Results of the MP reinforcer assessment for both progressive schedules are shown. The graph depicts the response per minute (RPM) for both schedules.

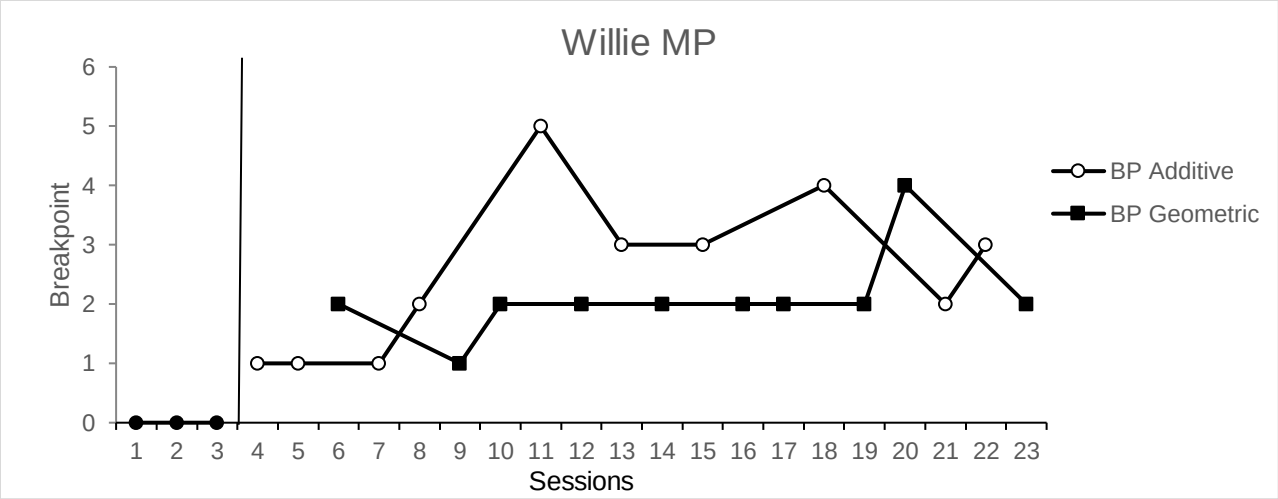

Figure 17. Results of the MP reinforcer assessment for both progressive schedules are shown. The graph depicts the breakpoint for both schedules.

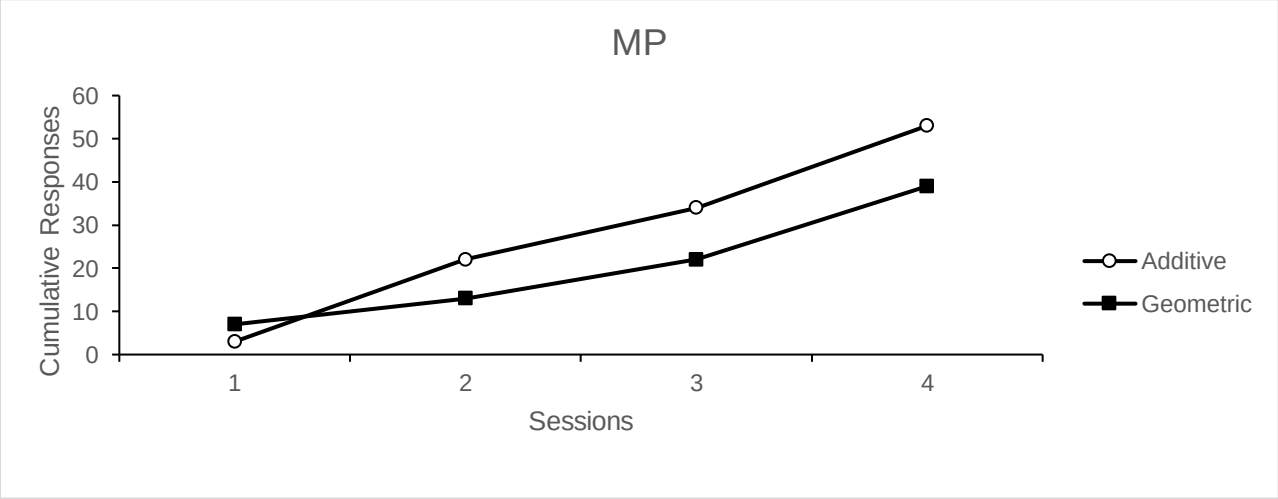

Figure 18. Results of the MP reinforcer assessment for both progressive schedules are shown. The graph depicts the cumulative number of responses for both schedules across the sessions.

Low preference (LP). Figures 19-21 illustrated the responses observed during the LP reinforcer assessment for Evan. Figure 19 shows the responses per minute for Evan. He responded to the tasks under the additive schedule at a rate of .18 and completed 48 of 74 tasks (M= 65% task completion). Under the geometric schedule, the response on the task were correct 133 of 160 tasks (M= 83% task completion). A higher rpm of .21 was demonstrated in the geometric schedule.

Figure 20 shows the breakpoint demonstrated by Evan. Evan had the highest breakpoint observed during the LP reinforcer assessment. The breakpoint (M=16) was observed twice, and breakpoint 8 was demonstrated three times during the geometric schedule. The average geometric breakpoint (M= 8.9) was significantly higher than the mean additive breakpoint (M= 2.9). The highest breakpoint observed during the additive schedule was 5. He terminated both schedules twice and completed the maximum session time (20 minutes) four times within geometric sessions and did not complete maximum session time during any additive sessions. Figure 21 shows the cumulative number of responses completed by Evan. A substantial difference can be observed between the two schedules based on the slope of cumulative number. Evan immediately responded faster during the geometric schedule, thus showing a steep slope increasing throughout the implementation of the schedule.

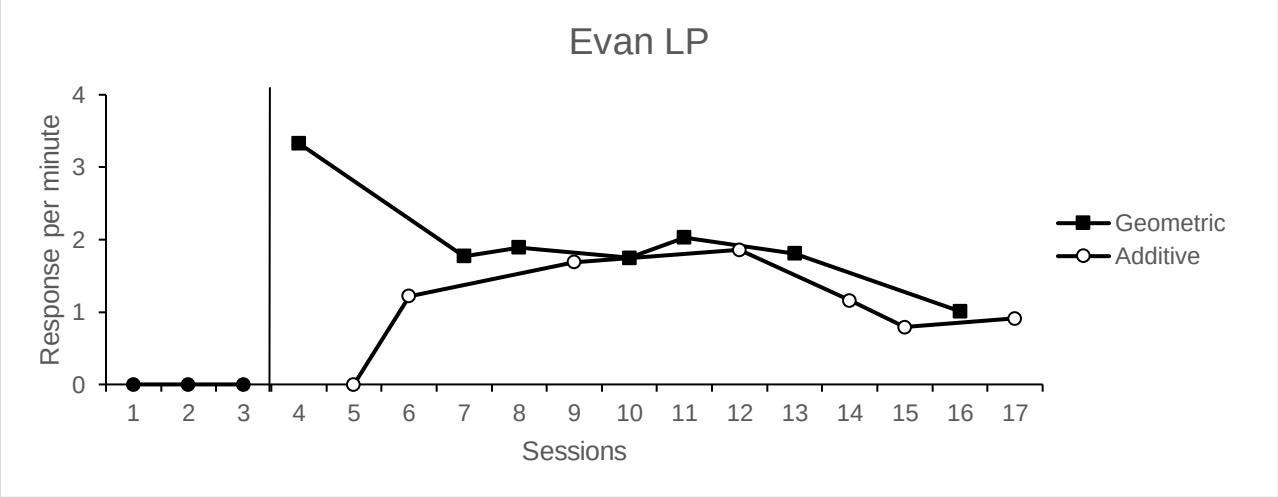

Figure 19. Results of the LP reinforcer assessment for both progressive schedules are shown. The graph depicts the response per minute (RPM) for both schedules.

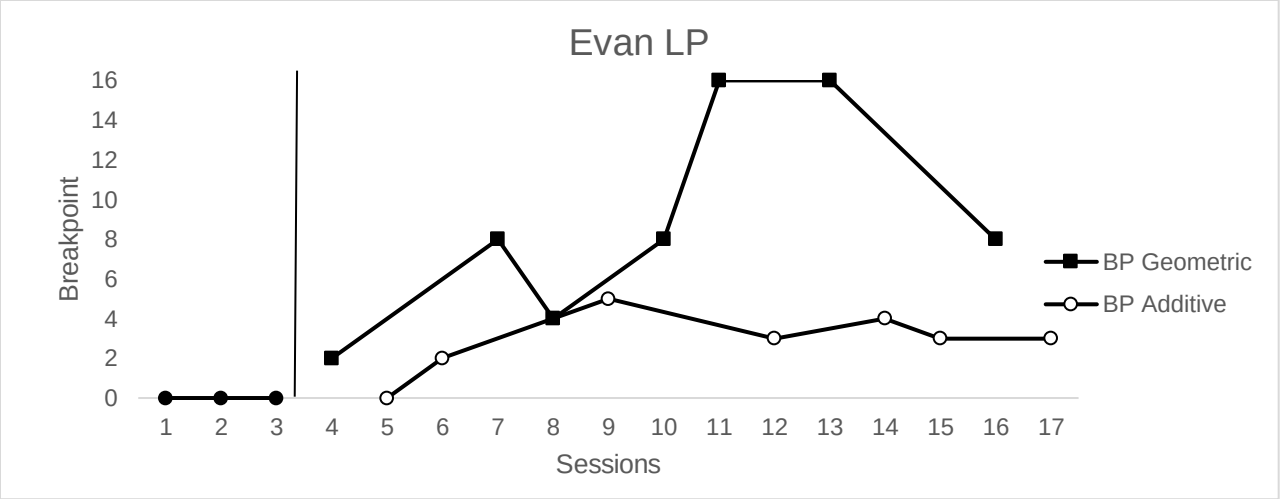

Figure 20. Results of the LP reinforcer assessment for both progressive schedules are shown. The graph depicts the breakpoint for both schedules.

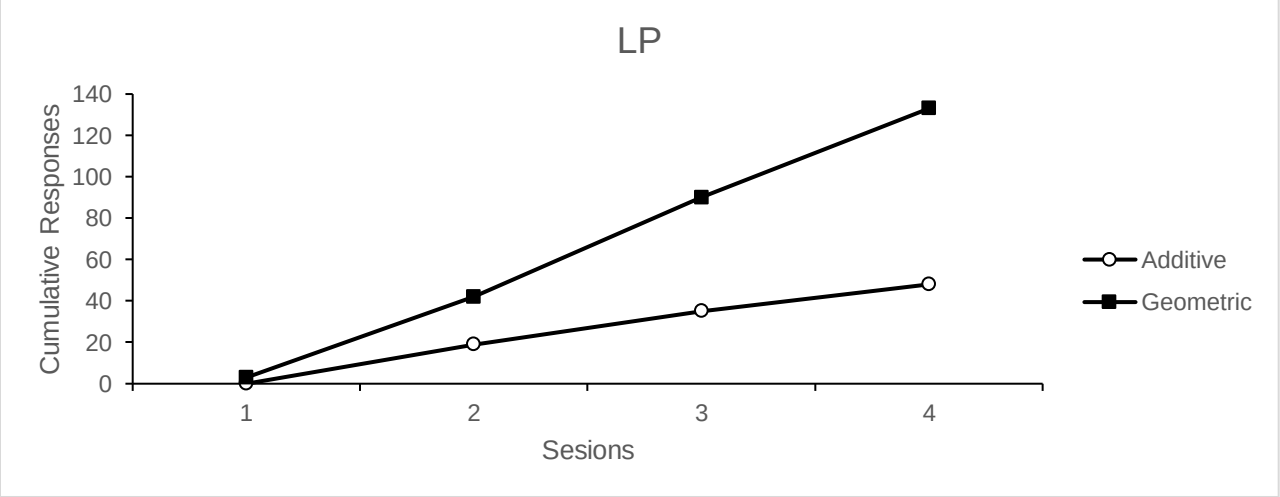

Figure 21. Results of the LP reinforcer assessment for both progressive schedules are shown. The graph depicts the cumulative number of responses for both schedules across the sessions.

Figures 22-24 illustrate the data collected for Michael during the LP assessment. In the LP reinforcer assessment, Michael responded at a higher rate to the additive schedule compared with his response rate under the geometric schedule. Michael responded at a faster rate to tasks when interacting with the additive schedule (M= 4.2 rpm) as well as completed more tasks (M= 88) more accurately (M=77% task completion). Michael completed the 72 tasks during the geometric

schedule at 73% accuracy, with a mean rpm of 3. Figure 23 shows the breakpoint data for Michael. The highest breakpoint (M=5) was observed during the additive schedule. Comparatively, the breakpoint observed in the geometric schedule was 4. The mean breakpoint for the schedules were equal (M=3). He did not terminate nor continue for the maximum session time. Figure 24 shows the data for the cumulative number of tasks completed during the PR schedules. A steady slow rising slope is observed for both schedules. The slopes are parallel with the additive slope showing a slightly higher cumulative number of tasks throughout the assessment. During the last session an increase in the rate of completion is illustrated in the slope of the additive schedule.

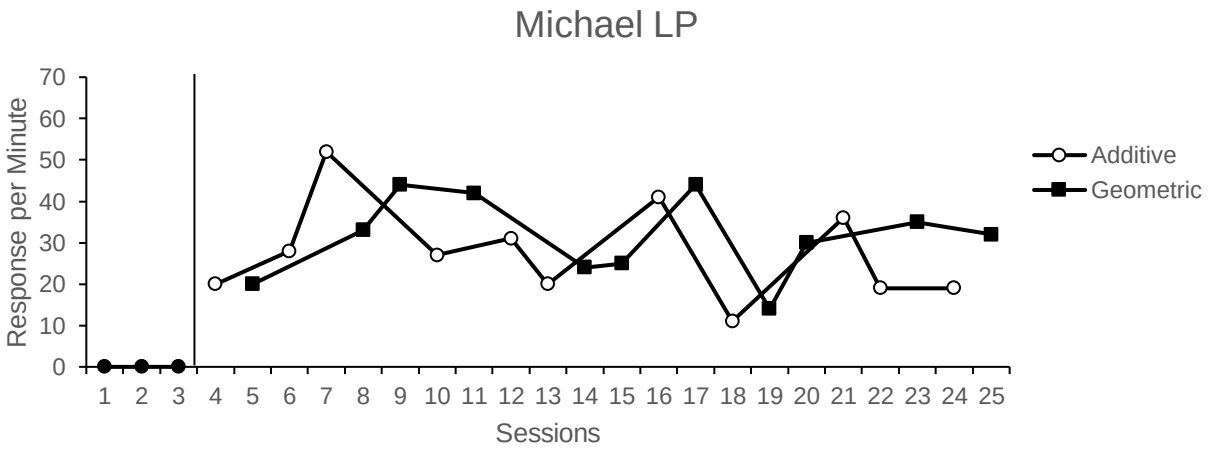

Figure 22. Results of the LP reinforcer assessment for both progressive schedules are shown. The graph depicts the response per minute (RPM) for both schedules.

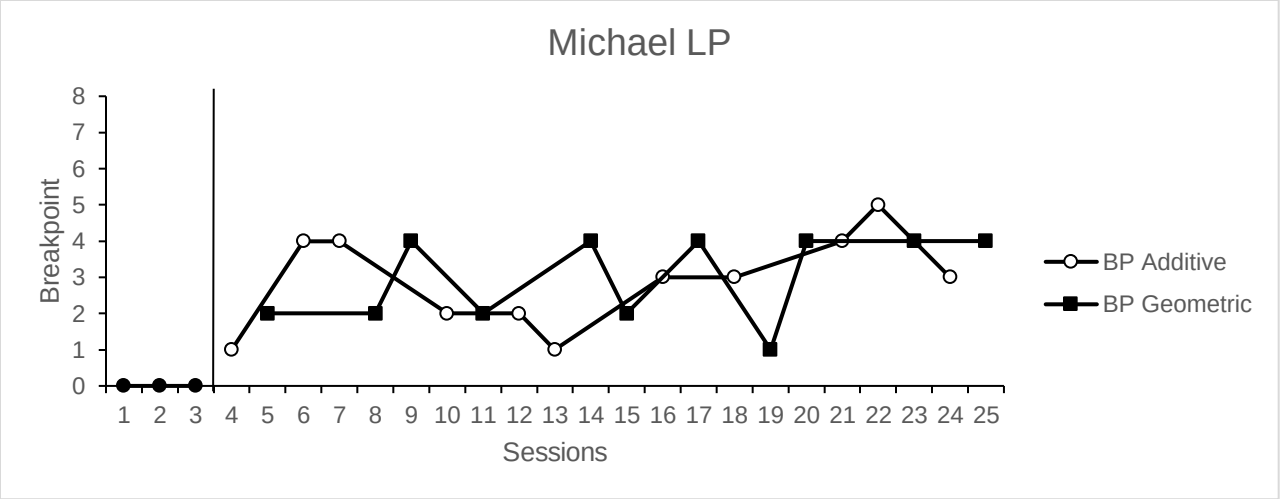

Figure 23. Results of the LP reinforcer assessment for both progressive schedules are shown. The graph depicts the breakpoint for both schedules.

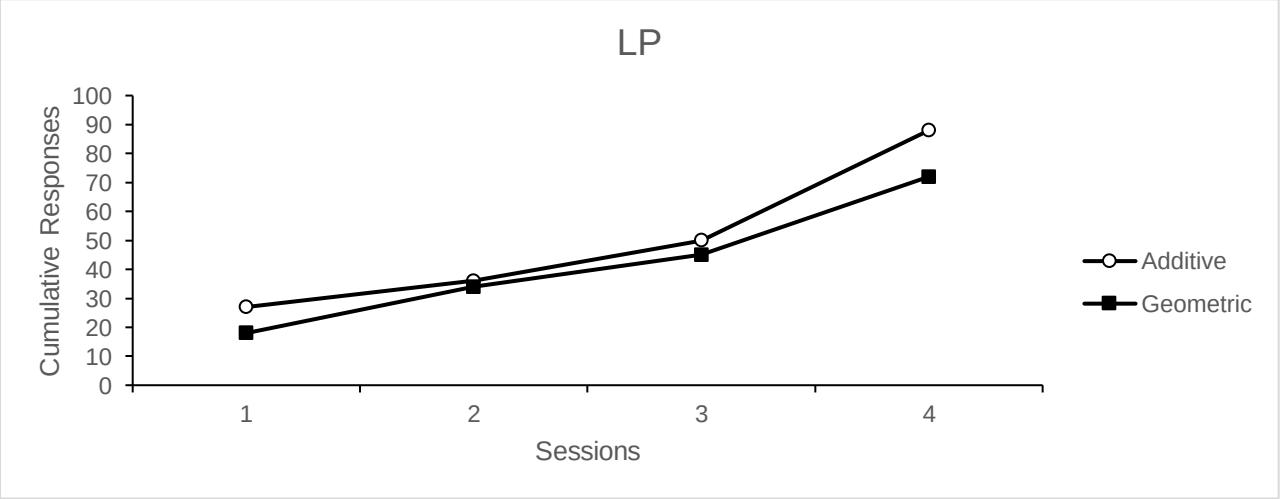

Figure 24. Results of the LP reinforcer assessment for both progressive schedules are shown. The graph depicts the cumulative number of responses for both schedules across the sessions.

The data for Willie's responses for the LP stimulus are shown in Figures 25-27. Figure 25 shows the response per minute for Willie. A slight, but insignificant difference is reported by the rpm for the two schedules. He responded to the tasks in the geometric schedule at a faster response per minute (M=.06) than the additive (M=.04). Willie's responses for the LP reinforcer were equal for both schedules. Figure 26 shows the breakpoint data for Willie. The highest breakpoint

demonstrated was 1 for both schedules, reaching a mean breakpoint of .5 (M= .5). He completed 3 out of 12 tasks correctly (M= 25%) for both progressive ratio schedules. He terminated all twelve sessions across both schedules. Figure 27 shows the cumulative number of responses collected for each schedule. The slope of the two PR schedules were identical. A steady, positive response was collected during the assessment for both schedules.

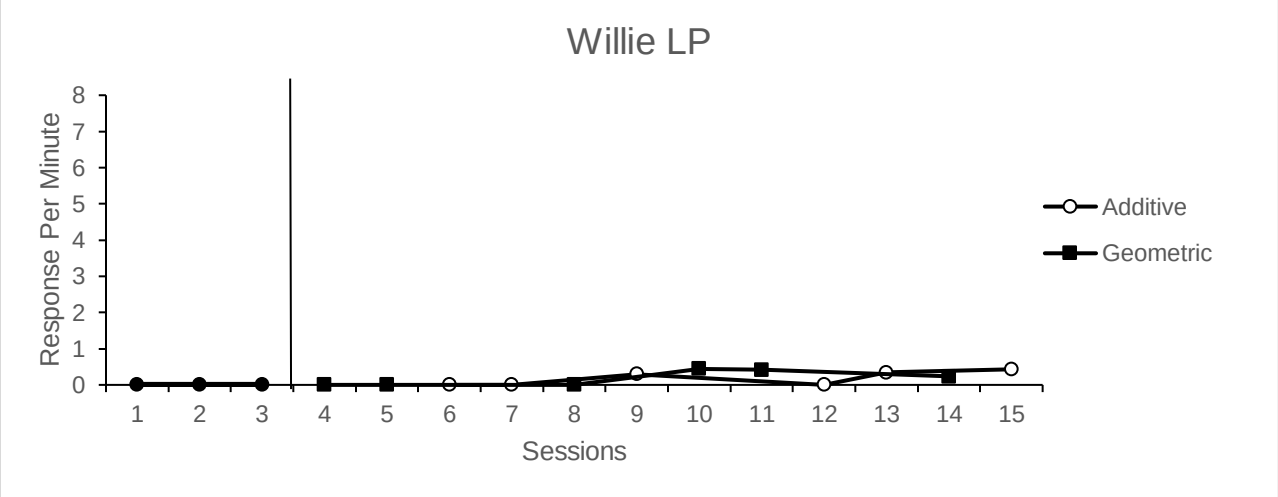

Figure 25. Results of the LP reinforcer assessment for both progressive schedules are shown. The graph depicts the response per minute (RPM) for both schedules.

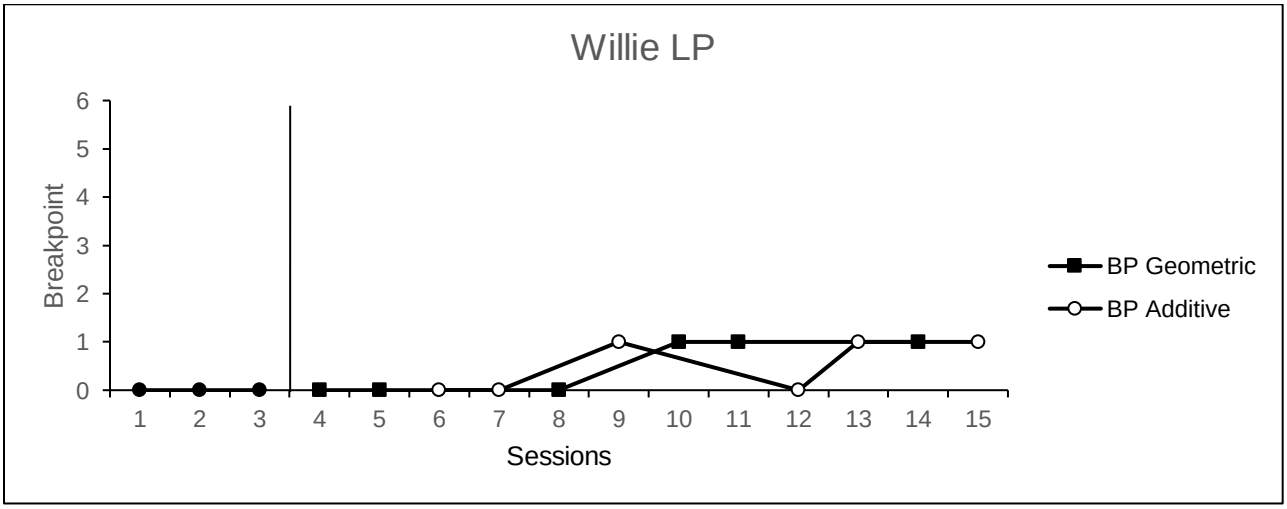

Figure 26. Results of the LP reinforcer assessment for both progressive schedules are shown. The graph depicts the breakpoint for both schedules.

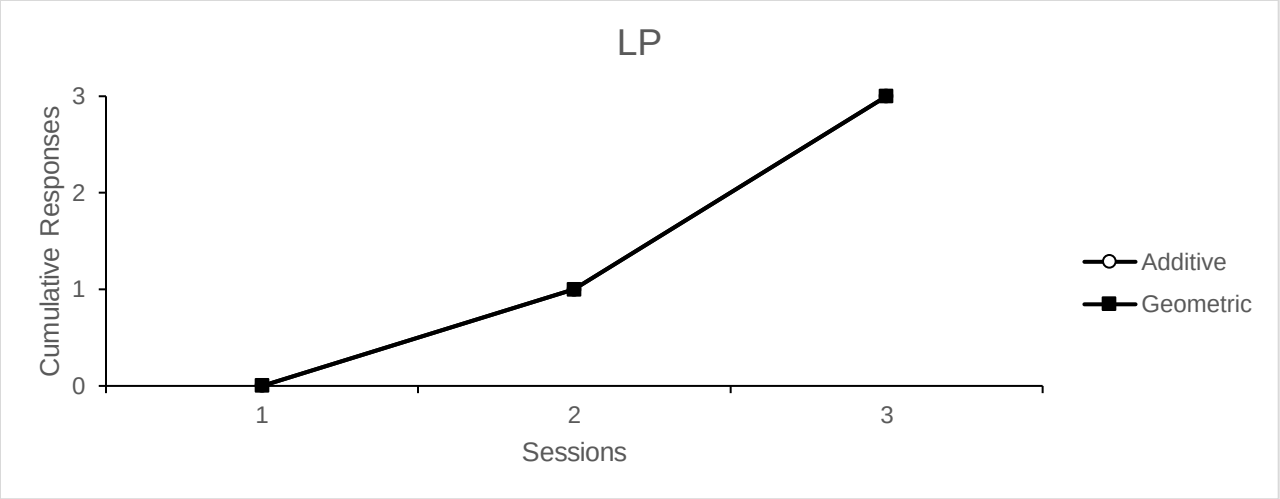

Figure 27. Results of the LP reinforcer assessment for both progressive schedules are shown. The graph depicts the cumulative number of responses for both schedules across the sessions.

Summary

For two of the three participants, the HP stimuli supported a higher mean breakpoint than the MP and LP stimuli during the additive schedule. One participant, Evan, responded with the highest mean breakpoint during the geometric schedule of the LP reinforcer assessment. Two of the participants (Evan and Michael) completed their highest breakpoints during the geometric schedule; the breakpoints occurred during the LP condition for Evan and during the MP condition for Michael.

The greatest cumulative number of responses were achieved during the additive schedule for all three participants, with the exception of Evan and Willie's LP reinforcer assessment. Willie emitted three responses during both schedules during the LP assessment. Under the additive schedule, the average rpm was higher for two of three participants (i.e. Michael and Evan). Evan completed the tasks at a higher rpm during the HP and MP assessments, while Michael completed the tasks at a higher rpm during all three reinforcer assessments. Willie performed at a higher average rpm during the geometric schedule for two reinforcer conditions. All three participants

made fewer errors during the additive schedule for two or more reinforcer assessments. Thus, two of three participants responded at higher rates and completed more tasks during the additive schedule. Participants' terminated more trials during the presentation of the geometric schedule. Evan reached the maximum session time six times during the geometric schedule; he reached the maximum session time only two times during the additive schedule.

Chapter Five: Discussion

This study was primarily intended as a comparative investigation of the difference between participants' responses to a task under two progressive-ratio schedules (i.e., geometric and additive). Furthermore, the study served as an examination of the variations in response levels across an array of preferences (HP, MP, LP) under the two increasing schedule requirements. The study utilized a MSWO preference assessment to identify the stimuli for each participant. The three identified stimuli were categorically ranked as HP, MP, and LP to be analyzed during three independent reinforcer assessments. The reinforcer assessments were assessed under the two progressive ratio schedules. The additive and geometric progressive ratio schedules were conducted in a single-operant arrangement for each reinforcer assessment. The dependent variables collected during the reinforcer assessment were: (a) the breakpoint, (b) responses per minute, and (c) the cumulative number of responses. The data were further analyzed using mean breakpoint, average response per minute, total tasks correct, cumulative number of tasks completed, and sessions terminated. The study's analysis went beyond the BP of the stimuli so as to further determine potential differences in response types and rates under the different PR arrangements.

Reinforcer Assessment

The results for two of three participants are consistent with the research on reinforcer assessments under progressive ratio schedules. The results derived from both Michael and Willie's assessments support the notion that HP stimuli yields a higher mean BP compared to either the MP and LP reinforcer (DeLeon et al., 2009; Call et al., 2012; Glover et al., 2008). In addition to confirming DeLeon et al.'s findings for the HP, the MP stimuli supported higher mean break points than the LP stimuli for two of three participants (see also Call et al., 2012). The findings for Willie are consistent with previous findings found in the literature. As Penrod et al. (2008) found, the LP

stimulus was not as effective as the HP stimulus under both PR schedules. Willie's response on tasks corresponded with the ranking of the stimuli. The HP stimulus supported higher mean BP, more total responses, and the highest accuracy of task completion. DeLeon et al. (2009) suggested that participants may complete a higher number of responses when higher preference stimuli are provided. Willie had the fastest rate of responding when engaged with the MP stimulus but did not complete as many tasks correctly when compared to the HP stimulus. Thus, one participant (i.e., Willie), his response level for reinforcers were correlated to the order of preference under the increasing schedule requirements (DeLeon et al., 2009).

The results of the study support the suggestion of Glover et al. (2008): namely, that individuals with ASD may vary their response levels across a hierarchy of stimuli under increasing schedule requirements. The results of both Michael and Evan's assessments were consistent with research on reinforcer assessments; an LP stimulus can function as an effective reinforcer when presented singularly (Francisco et al., 2008; Penrod et al., 2008; Roscoe et al., 1999). This study seeks to highlight an important, and hitherto unaddressed, distinction when considering an LP stimulus as an effective reinforcer. In previous research, the LP reinforcer was shown to be effective under various methodological procedures. Specifically, it was effective under a FR1 single operant schedule (i.e., Roscoe et al.) and under an additive PR schedule (i.e., Francisco et al.; Penrod et al.). Therefore, research has demonstrated the LP stimulus' tendency to maintain response rates under a PR additive schedule, but not under a PR geometric schedule. The current study extends the PR-based literature by providing data on a LP stimulus maintaining high response rates under a geometric schedule in an applied setting and arrangement.

Only one participant (i.e., Evan) engaged in the highest BP during the LP reinforcer assessment, which was a similar result as that of a participant in Glover et al. (2008). However, in

Glover et al., the LP reinforcer assessment was conducted only under an additive PR schedule, and not under a geometric schedule. During the progression, a BP of 16 was demonstrated twice, and a BP of 8 was demonstrated three times. The LP stimulus was shown to have high reinforcer potency with this participant, as it was correlated with the highest BP, highest cumulative number of responses, least number of terminated sessions, and maximum session length. Although the stimulus was shown to have low reinforcer preference through the preference assessment, it was nevertheless considered as a highly potent and a preferred stimulus in the experiment. In comparison to the other preferences, Evan often chose to not engage with the HP and MP stimuli during the respective reinforcer assessment; therefore, though selected as a higher preference, the HP stimulus was not as effective when presented to the participant.

When analyzing the variability with Evan, it appears the effectiveness of the LP stimuli as a reinforcer fluctuated as a function of motivating operations (MO; Laraway, Snycereski, Michael, and Poling, 2003), though this observation must be made cautiously. As reported by Russell, Ingvarsson, Haggar, and Jessel (2018), reinforcer effectiveness may fluctuate as a function of MOs. For instance, on the session day which yielded the highest recorded BP response for the LP, it was reported that Evan had an easy schedule at home and watched TV prior to the researcher's arrival. The presence of tv watching prior to sessions may have had a value altering effect on the paper and markers (LP stimulus). The antecedent event appeared to also increase scripting during the sessions conducted that day. In total, four data points were collected: three during the geometric schedule (4, 5, & 6) and one during the additive schedule (data point 4). When conducting the sessions, the verbal scripting of the TV show was extremely high. When the schedule requirement was completed, the LP stimulus provided another outlet for the scripting. The participant engaged in a common self- stimulatory behavior of writing the verbal scripts. In previous LP sessions, the

participant's parent stated that Evan was unable to watch TV prior to our session, and as such the correlation to scripting was low. Evan's consistent engagement with the LP stimulus during the reinforcer break stands as a significant difference between the LP and other stimuli. The stimuli chosen more frequently were not as effective of a reinforcer for BP as other stimuli; nevertheless, the stimuli appeared to ease the participant's anxious behaviors. For example, both stimuli allowed Evan to check his parent's calendar. This behavior appeared to ease anxiety surrounding events scheduled throughout coming days. The need to check the calendar was described as a common occurrence.

Similar to Evan's results, the preferred LP stimulus of Michael was a stimulus that evoked stereotypy behavior in comparison to two puzzles selected as the HP and MP stimuli. The LP stimulus was a low effort item in which he repeatedly swirled a marker on the paper. The stimulus supported the completion of tasks with the highest accuracy. Michael completed a similar number of tasks for the MP (n=161) and LP (n=160) stimuli. However, he completed fewer tasks for the HP stimulus (n=127). Two differences are observed between the varying preference levels. The tasks presented in the LP assessment were completed at the highest rate of accuracy and a higher rate of responding when compared to the MP stimulus. Confirming and furthering the findings of Penrod et al. (2008) and Francisco et al. (2008), the LP stimuli was an effective reinforcer under the PR schedules. Even though the MP stimulus completed the highest schedule requirement, Michael committed errors at a higher rate during trials and demonstrated the slowest response time on the tasks throughout the assessment. High variability was observed under the MP stimulus for the participant, but the results support the findings of DeLeon et al. (2009); the MP stimulus supported higher mean breakpoints than the LP stimulus. The rate of response for the HP stimulus was the fastest; the amount of work supported by the stimulus was lower than other stimuli, but

the response rate was high. The participant worked fastest for the HP stimulus supporting the highest mean BP, mirroring the results found by three of four participants in DeLeon et al.

Upon analysis of the varying responses from participants according to the gradient levels of preferences, it appears the dependent variables had correspondingly variable responses dependent on the range of preferred stimuli. During the HP reinforcer assessment, the BP mean was the highest for the stimuli with the highest rate of responding. During the MP assessment, the slowest rpm was exhibited, but the most tasks were completed during the assessment. Lastly, observations of the work completed for the LP stimulus yielded stable rate and response times for the tasks. Though the task completion was lower, the participant completed the tasks at a more rapid pace. This study suggests that researchers examining a preference assessment may need to consider the efforts required by participants to engage with the various stimuli in the assessment. For instance, in the present study, it took less effort for participants to engage in the markers and paper, rather than complete a 12-piece puzzle or engage with a cell phone, within the allocated earned-reinforcement time. This effect was exhibited within the assessment of two of the three participants. With the two participants, the stimuli that elicited stereotypy behaviors were found to have the highest reinforcer potency, though contrasted with a low preference. Furthermore, the study suggests that a stimulus that maintains stereotypy behavior may be best presented under a geometric schedule rather than an additive schedule – perhaps at any stimulus preference level. Under a leaner schedule of reinforcement (i.e., geometric schedule), we observed higher schedule requirements. The assumption is that due to less distractions (i.e., less engagement with the LP stimulus) the participants were able to stay on task to demonstrate capability of the higher schedule requirements.

Progressive Ratio Schedule

A survey of PR schedules references yields several hundreds of articles based on experimental and clinical research. One study (i.e., Killeen et al., 2009) performed with pigeons found that geometric progressions yield different breakpoints than additive progressions. The rates and BP under the additive schedule were lower than their counterparts under the geometric schedule. The benefits of a geometric progression have been discussed in the literature and include a faster progression to task response completion (i.e., breakpoint), yet the schedule implemented is typically determined by the research question. Accordingly, limited research has been conducted on the effects of the geometric schedule compared to other schedules of reinforcement. The below discussion will highlight with differences between dependent variables during the administration of two PR schedules.

Evan. Higher schedule requirements were reached under the geometric schedule across all three reinforcer assessments with Evan. As discussed, the LP stimulus was associated with the highest BP, followed by the HP and MP stimuli respectively. Evan responded the highest during the geometric schedule for all of observed dependent variables (i.e., cumulative number of responses, mean RPM, BP). Hence, Evan was most responsive to the LP stimulus under the geometric schedule. Evan responded faster under the geometric schedule (i.e., higher rpm), committed less errors, and displayed a high motivation to respond during the schedule resulting in the highest BP. During the LP assessment, observations on why Evan responded with a higher BP for the geometric schedule can be hypothetically explained by the leaner schedule of reinforcement resulting in a reduction in the ability of the participant to engage in the stimulus that evoked stereotypy behavior. The additive schedule provided the stimulus through a denser schedule of reinforcement, which appeared to be more overwhelming for the participant. Under the additive

schedule, an increase in the rate of scripting was observed during consecutive trials; a higher rate of errors occurred during the lower schedule requirements. This observation may explain why the additive schedule received lower responses during sessions affected by the MO. By receiving more tasks at one time under the geometric schedule, Evan was able to maintain on-task behavior and achieve a higher BP. Under the additive schedule, Evan completed 48 tasks compared to the 133 tasks he completed during the geometric schedule; the additive schedule also yielded task completion by the participant at a slower rpm. The conclusion of the results demonstrates that a highly motivating stimuli can maintain responses under a leaner schedule of reinforcement while simultaneously yielding the completion of more task requirements. Even though the LP stimulus was not as preferred as the HP stimulus, it was shown to be more potent (see also Roscoe et al., 1999). Most importantly, this demonstrates that an LP stimulus can be an effective reinforcing stimulus — even more effective than a HP or MP stimuli for some variables — when implemented in a single-arrangement. This conclusion contradicts the findings of Glover et al. (2008), who found that a LP stimulus did not produce a higher BP than the HP stimuli. However, the results of Francisco et al. (2008) are supported by the findings of the current study; namely, an LP stimulus can support moderate-to-high BPs when testing the LP stimulus independently from variant levels of stimuli.

Evan's data begs a potential future research question, "do participants respond differently under different progressive ratio schedules across an array of preferred items?" Higher responses were observed for the dependent variables under the additive schedule for two of three stimuli (i.e., HP and MP). The participant exhibited the most responses during the additive schedule accounting for cumulative responses, average RPM, and total tasks correct. However, Evan did complete more responses in a trial correlating to higher schedule requirements under the geometric schedule; this

resulted in higher BPs for the HP and MP stimuli. For all three reinforcer assessments, a greater variability in responses was observed under the additive schedule with Evan.

A visual analysis of the cumulative number of responses in the LP condition illustrates the consistency and response rate via a steep slope for the geometric progression (see Figure 21). In comparison, the slope of the additive schedule illustrates a slower rate of response, with more observable breaks. A gradual and steady increase is shown in the MP condition (see Figure 12) for both schedules, demonstrating little difference between the schedules in regard to response patterns. In the HP condition, the response rate observed during the additive schedule was consistent and steady relative to the gradual increase of the geometric progression. In general, the participant had a faster, and more accurate, rate of response under the additive schedule for the HP and MP stimuli. Moreover, Evan terminated fewer trials during the additive schedule than the geometric schedule; this perhaps indicates higher participant acceptance of the additive schedule. Thus, the observable difference in results within the progressive schedules is that, under the additive schedule, the participant stayed on task to complete more accurate tasks at a faster rate. If the sole behavioral target is to achieve higher task responses within a trial (BPs), the current results support the use of the geometric progression.

Michael. During Michael's assessments, the highest schedule requirement (n=8) was obtained under the geometric schedule during the MP reinforcer assessment. Within the HP reinforcer assessment, Michael was unable to complete the schedule requirement of eight under the geometric schedule; the highest BP recorded was four. The highest BP occurred during the additive schedule for the HP and LP stimuli. He maintained more stable task completion under the geometric schedule when compared to the additive schedule for the LP and HP stimuli. The additive schedule maintained a response rate for the highest BP for the LP and HP assessment;

however, the additive schedule had more response variability throughout the presentation of the reinforcer assessments. For two of three reinforcer assessments, the mean BP was consistently higher under the additive schedule. Throughout the HP, MP, and LP reinforcer assessments, higher responses were exhibited under the additive schedule than with the geometric schedule. For all three reinforcer assessments, Michael completed a higher frequency of tasks more accurately, and at a faster rate, under the additive schedule. Therefore, when comparing the two PR schedules, introduction of the task in an additive presentation, rather than a geometric presentation, achieved a higher response from the participant across the differing level of preferences.

We arrive at two conclusions by analyzing both progressive schedules. First, in two of the three reinforcer assessments, the researcher can determine that Michael was able to successfully complete more tasks in the additive schedule. This conclusion is supported by the breakpoint differential observed between the geometric and additive progression in both the HP and LP reinforcer assessments. Second, a higher breakpoint was exhibited for the moderately preferred stimulus over the highly preferred stimulus; however, the highest breakpoint was demonstrated in the geometric schedule for the MP and in the additive schedule for the HP. Thus, the geometric progression yielded different breakpoints than with the arithmetic progression as reported by Killeen et al. (2009). The slope of the cumulative number of responses provides a visual demonstration of the difference of response rates between the two schedules. When the reinforcer quality was low, very little difference could be observed between the two schedules of progression. However, when higher preferred stimuli were examined, observable differences in response levels became apparent between the two schedules. The consistent responses during the additive schedule can be observed within the steep slope of the HP and MP conditions (see Figures 6 & 15), in comparison to the slow rising and similar slopes during the LP condition (see Figure 24).

Willie. The responses exhibited by Willie are consistent with those results reported by Glover et al. (2008) and Penrod et al. (2008); namely, the HP stimulus was associated with the highest mean breakpoint. Higher responses were observed under the additive schedule throughout the HP and MP reinforcer assessments. Similar results were exhibited between the schedules for the LP reinforcer assessment. The geometric schedule had a slightly higher rpm, by .02. Therefore, for this participant, varying response levels were not observed between the schedules of reinforcement within the LP condition. Comparing both progressive schedules in the MP assessment, the participant successfully exhibited responses beyond the schedule requirement of two. In the geometric schedule of the MP condition, Willie was unable to increase from two tasks to four tasks without committing error. However, in the additive progression, he was able to successfully complete more than two tasks within a considerable number of trials. Therefore, for this participant, implementing the additive schedule resulted in the task being completed at a higher response rate and with more total tasks correct. Willie completed tasks slightly faster under the geometric schedule but did not complete as many tasks accurately. In comparison, Willie successfully completed a significant number of responses under the additive schedule (n=72) compared to the geometric progression (n=22) in the HP condition. For this participant, the additive progression was demonstrated to be the more effective schedule in maintaining responses at a faster rate.

When plotted, Willie's cumulative number of responses across the three stimuli provide another analysis of the participant's data. Under the LP condition, there were no observable differences in effects between the two schedules and the rate of response. A steady response pattern is observed during the MP condition for both of the progressive schedules; however, the additive schedule increased at a faster rate than with the geometric. A slower response rate – due to the

participant taking more breaks between responses – is illustrated in the slope of the HP geometric schedule. A steady response rate was observed under the additive schedule until the slope increased considerably for the HP stimulus in the last session.

Limitations

An increase in the mean break point and ranges between the reinforcer assessments may be due to the increased exposure to the contingency, as well as the mastery of the task. By continuous exposure and completion of the task, the rate of response may be faster based on the mastery of the task. However, in reviewing the PR schedule effects, no carryover is observed in the data. A clear response to the PR schedule with no carryover may be observed between two LP data points of Evan's. Geometric data points 11 and 13, and additive data point 12. Evan is clearly responsive to the geometric schedule rather than the additive schedule. The occurrence of the EO that day applied to both schedules and data points collected.

A possible limitation of the study is the difference in effort put forth by participants to engage with the stimuli implemented. For instance, two participants engaged with puzzles with multiple pieces; however, at the end of the reinforcer period the puzzle was possibly removed with some pieces not placed. Neither participant seemed to respond negatively to the removal of the stimulus, but it may have been an aversive interaction with the stimulus assessed. Furthermore, attempting to finish a puzzle or play an electronic game within 20-s takes far more effort from the participant compared to engaging with markers and paper. Perhaps lending itself to why the LP stimuli had higher reinforcer potency for two participants. Lastly, due to conducting the sessions in the home setting, distractions were limited but impossible to avoid. Parents and caregivers were instructed to not alter day-to-day schedules and normal interactions with stimuli in any manner

and were further told not to engage with participants with regards to the task. However, there is no manner in which to have 100% assurance that these restrictive instructions were adhered to.

Implications

The current results may have implications with regard to possible benefits to the future employment of individuals with ASD. One potential limitation of the current study was that engagement with the stimuli may have been affected by the time constraint of reinforcement intervals during the reinforcer assessment. As such, perhaps participants would have found the puzzles or electronic devices more reinforcing if additional time was allotted for engagement. In an applied setting, future researchers and employers could asses the implementation of tokens as a generalized reinforcer to keep individuals on task without engaging with a reinforcer every 20-s. As DeLeon et al. (2014) found accumulated reinforcer arrangements, rather than distributed arrangements produced, on average, higher response rates and were preferred by participants. Accumulated reinforcement implies a longer, delayed reinforcement break compared to a shorter, immediate duration of reinforcers across several sessions (i.e., distributed reinforcement). For example, an employee receiving tokens while completing the vocational task signaling a reinforcement break at the end of the work session rather than receiving 30-s of reinforcer access every minute.

By implementing tokens, it signals the earned, but delayed reinforcement, while increasing the time on task and decreasing the number of transitions from task to reinforcer; therefore, the participants would receive longer, uninterrupted access to the reinforcer and engage with a variety of stimuli. Based on the findings of the two progressive schedules, future researchers should assess how to efficiently implement a vocational skill in an applied setting under the two increasing schedule requirements. In an attempt to further the results of the study and increase the number of

individuals with ASD in a vocational setting, providing employers with two schedules to increase the total tasks completed at a faster rate while decreasing break time for reinforcement is beneficial to this population.

Conclusion

The current study, conducted on three differing levels of stimulus preference, analyzed reinforcer assessments under two PR single-schedule arrangements. The conclusion of the findings indicates that, for two of three participants, the highest BP was obtained during the geometric schedule. However, across all three participants, considerably more responses were observed under the additive schedule for the differing levels of preferred stimuli. The results suggested that the additive schedule more consistently achieved a higher number of responses when compared to the geometric schedule. In the comparison of the schedules, the additive schedule increased the task demand slowly, therefore gradually establishing a leaner schedule of reinforcement. This allowed the participants to complete the highest mean schedule requirement. More tasks were completed accurately, and at a faster rate, under the additive schedule. Though the mean BP was highest under the additive schedule for 2/3 participants (i.e., Michael and Willie), a higher schedule requirement was accomplished under the geometric schedule for 2/3 participants (i.e., Evan and Michael).

In designing the current study, several methodological considerations were taken into account. Based on a survey of previous literature, several components of PR schedules are still under investigation, thus inconsistency between various studies is common. The procedural considerations for this study included: (a) the PR algorithm, (b) the experimental design, (c) the differing levels of stimuli, and (d) the target response of each participant. A developmentally, age-appropriate target response for an applied setting was selected for the participant's task.

Given broader, real-world focus on self-sufficiency and employment, it was important to extend the literature by implementing a complex task appropriate for an applied setting (i.e., job setting).

Accordingly, to further the literature, this study focused on extending the findings of the differing levels of stimuli under a PR schedule. A notable difference between this study and the study completed by Glover et al. (2008) is that, in the present study, the lowest stimuli selected during the preference assessment was not selected for examination. Instead the stimuli selected was fifth of six (*n*=22%) so the effectiveness of the LP stimuli remained plausible. The ranking of the stimuli implemented as the LP is similar to the implementation utilized by Francisco et al. (2008), in which the researchers studied the stimuli selected during 22% of trials during the preference assessment. Thus, the findings of the LP stimuli as an effective reinforcer supports the findings of Francisco et al. This study accounted and controlled for a limitation stated by Penrod et al. (2008). The researchers expressed concern regarding task preference, due to the implementation of distinct tasks for the HP and LP reinforcer assessments. In the Penrod et. al (2008) study, participants' responses may have been elicited by the task – and not the stimuli. In this present study, the task and task materials were identical for both PR schedules and reinforcer assessments. This procedure was selected to limit any participant-bias towards the task or schedules.

As discussed by DeLeon et al. (2009), meaningful differences may be observed when PR schedules are examined separately beyond the response rate for each stimulus. In Penrod et al. (2008) and Francisco et al. (2008), reinforcement was provided during the LP reinforcer assessment on an FR 1 schedule. The study conducted by Glover et al. (2008) assessed the PR schedules as a single operant schedule and concurrent schedule for the same preferred stimuli. The PR schedule assessed was an additive schedule. The design of the current study was an alternating

treatment design of two PR schedules in a single-operant arrangement. The HP, MP, and LP stimuli were all assessed under increasing schedule requirements, both additive and geometrically. The LP stimuli was shown to be an effective reinforcer for two of three participants, and for one participant a more effective reinforcer than the HP stimuli. This further develops existing literature by demonstrating participants' responsiveness to the LP stimuli under a PR single operant schedule, as opposed to solely a FR schedule. Furthermore, data were collected on variables beyond the BP and rate of responding. The cumulative number of responses and terminated sessions were also collected to further the research on individuals' response level on differing levels of stimuli under increasing schedule requirements.

Appendices

Appendix A

Multiple Stimuli without Replacement (MSWO) Data Sheet

Child's Name: _____ Leisure/Food (Circle one)

Evaluator: _____ Date: _____

List of Items:

_____ _____ _____ _____ _____ _____

Preference Assessment #1	
Order of items selected	# times chosen/ # of times available
1.	
2.	
3.	
4.	
5.	
6.	

Preference Assessment #2	
Order of items selected	# times chosen/ # times available
1.	
2.	
3.	
4.	
5.	
6.	

Preference Assessment #3	
Order of items selected	# times chosen/ # of times available
1.	
2.	
3.	
4.	
5.	
6.	

Preference Assessment #4	
Order of items selected	# times chosen/ # times available
1.	
2.	
3.	
4.	
5.	
6.	

Preference Assessment #5	
Order of items selected	# times chosen/ # of times available
1.	
2.	
3.	
4.	
5.	
6.	

Summary (high to low)	
Item	Total % Selected
1.	
2.	
3.	
4.	
5.	
6.	

Appendix B

Reinforcer Assessment: Progressive-ratio, Additive
HP stimulus

Participant's name: _____ Session Date: _____ Collector: _____

1) Circle the PR level that has been completed.
2) Write down the time total time for each response schedule (i.e., does not include reinforcement period)
3) Place * if terminated for NR or discontinued trial

Trail 1	PR Time PR Time	1 ___ 9 ____	2 ____ 10 ___	3 ___ 11 ___	4 ____ 12 ___	5 ____ 13 ____	6 ____ 14 ___	7 ___ 15 ___	8 ____ 16 ___	BP: Total Response Time:
Trail 2	PR Time PR Time	1 ___ 9 ____	2 ____ 10 ___	3 ___ 11 ___	4 ____ 12 ___	5 ____ 13 ____	6 ____ 14 ___	7 ___ 15 ___	8 ____ 16 ___	BP: Total Response Time:
Trail 3	PR Time PR Time	1 ___ 9 ____	2 ____ 10 ___	3 ___ 11 ___	4 ____ 12 ___	5 ____ 13 ____	6 ____ 14 ___	7 ___ 15 ___	8 ____ 16 ___	BP: Total Response Time:
Trail 4	PR Time PR Time	1 ___ 9 ____	2 ____ 10 ___	3 ___ 11 ___	4 ____ 12 ___	5 ____ 13 ____	6 ____ 14 ___	7 ___ 15 ___	8 ____ 16 ___	BP: Total Response Time:

Reinforcer Assessment: Progressive-ratio, Additive
MP stimulus

Participant's name: _____ Session Date: _____ Collector: _____

1) Circle the PR level that has been completed.
2) Write down the time total time for each response schedule (i.e., does not include reinforcement period)
3) Place * if terminated for NR or discontinued trial

Trail 1	PR Time PR Time	1 ___ 9 ____	2 ____ 10 ___	3 ___ 11 ___	4 ____ 12 ___	5 ____ 13 ____	6 ____ 14 ___	7 ___ 15 ___	8 ____ 16 ___	BP: Total Response Time:
Trail 2	PR Time PR Time	1 ___ 9 ____	2 ____ 10 ___	3 ___ 11 ___	4 ____ 12 ___	5 ____ 13 ____	6 ____ 14 ___	7 ___ 15 ___	8 ____ 16 ___	BP: Total Response Time:
Trail 3	PR Time PR Time	1 ___ 9 ____	2 ____ 10 ___	3 ___ 11 ___	4 ____ 12 ___	5 ____ 13 ____	6 ____ 14 ___	7 ___ 15 ___	8 ____ 16 ___	BP: Total Response Time:
Trail 4	PR Time PR Time	1 ___ 9 ____	2 ____ 10 ___	3 ___ 11 ___	4 ____ 12 ___	5 ____ 13 ____	6 ____ 14 ___	7 ___ 15 ___	8 ____ 16 ___	BP: Total Response Time:

Reinforcer Assessment: Progressive-ratio, Additive
LP stimulus

Participant's name: _____ Session Date: _____ Collector: _____

1) Circle the PR level that has been completed.
2) Write down the time total time for each response schedule (i.e., does not include reinforcement period)
3) Place * if terminated for NR or asked to discontinue trial

Trail 1	PR Time PR Time	1 ___ 9 ____	2 ____ 10 ___	3 ___ 11 ___	4 ____ 12 ___	5 ____ 13 ____	6 ____ 14 ___	7 ___ 15 ___	8 ____ 16 ___	BP: Total Response Time:
Trail 2	PR Time PR Time	1 ___ 9 ____	2 ____ 10 ___	3 ___ 11 ___	4 ____ 12 ___	5 ____ 13 ____	6 ____ 14 ___	7 ___ 15 ___	8 ____ 16 ___	BP: Total Response Time:
Trail 3	PR Time PR Time	1 ___ 9 ____	2 ____ 10 ___	3 ___ 11 ___	4 ____ 12 ___	5 ____ 13 ____	6 ____ 14 ___	7 ___ 15 ___	8 ____ 16 ___	BP: Total Response Time:
Trail 4	PR Time PR Time	1 ___ 9 ____	2 ____ 10 ___	3 ___ 11 ___	4 ____ 12 ___	5 ____ 13 ____	6 ____ 14 ___	7 ___ 15 ___	8 ____ 16 ___	BP: Total Response Time:

Reinforcer Assessment: Progressive-ratio, Geometric
HP stimulus

Participant's name: _____ Session Date: _____ Collector: _____

1) Circle the PR level that has been completed.
2) Write down the time total time for each response schedule (i.e., does not include reinforcement period)
3) Place * if terminated for NR or asked to discontinue trial

Trail 1	PR Time	1 _____	2 _____	4 _____	8 _____	16 _____	32 _____
	BP:		Total Response Time:		Notes:		

Trail 2	PR Time	1 _____	2 _____	4 _____	8 _____	16 _____	32 _____
	BP:		Total Response Time:		Notes:		

Trail 3	PR Time	1 _____	2 _____	4 _____	8 _____	16 _____	32 _____
	BP:		Total Response Time:		Notes:		

Reinforcer Assessment: Progressive-ratio, Geometric
MP stimulus

Participant's name: _____ Session Date: _____ Collector: _____

1) Circle the PR level that has been completed.
2) Write down the time total time for each response schedule (i.e., does not include reinforcement period)
3) Place * if terminated for NR or asked to discontinue trial

Trail 1	PR Time	1 _____	2 _____	4 _____	8 _____	16 _____	32 _____
	BP:		Total Response Time:		Notes:		

Trail 2	PR Time	1 _____	2 _____	4 _____	8 _____	16 _____	32 _____
	BP:		Total Response Time:		Notes:		

Trail 3	PR Time	1 _____	2 _____	4 _____	8 _____	16 _____	32 _____
	BP:		Total Response Time:		Notes:		

Reinforcer Assessment: Progressive-ratio, Geometric
LP stimulus

Participant's name: _____ Session Date: _____ Collector: _____

1) Circle the PR level that has been completed.
2) Write down the time total time for each response schedule (i.e., does not include reinforcement period).
3) Place * if terminated for NR or asked to discontinue trial

Trail 1	PR Time	1 _____	2 _____	4 _____	8 _____	16 _____	32 _____
	BP:		Total Response Time:		Notes:		

Trail 2	PR Time	1 _____	2 _____	4 _____	8 _____	16 _____	32 _____
	BP:		Total Response Time:		Notes:		

Trail 3	PR Time	1 _____	2 _____	4 _____	8 _____	16 _____	32 _____
	BP:		Total Response Time:		Notes:		

Appendix C

Data Collection Summary: PR Additive

Collector: _____ Date: _____ Participant: _____

PR Additive, LP	Breakpoint	Total Response Time	Cumulative Number of Responses
Baseline			
Trial 1			
Trial 2			
Trial 3			
Average:	BP/# of trials ____/____= _____	Sum of trails/ # of trials _____ /_____= _____	Sum of cum. num./ # of trials _____ /_____= _____

PR Additive, MP	Breakpoint	Total Response Time	Cumulative Number of Responses
Baseline			
Trial 1			
Trial 2			
Trial 3			
Average:	BP/# of trials ____/____= _____	Sum of trails/ # of trials _____ /_____= _____	Sum of cum. num./ # of trials _____ /_____= _____

PR Additive, HP	Breakpoint	Total Response Time	Cumulative Number of Responses
Baseline			
Trial 1			
Trial 2			
Trial 3			
Average:	BP/# of trials ____/____= _____	Sum of trails/ # of trials _____ /_____= _____	Sum of cum. num./ # of trials _____ /_____= _____

Data Collection Summary: PR Geometric

Collector: _____ Date: _____ Participant: _____

PR Geometric, LP	Breakpoint	Total Response Time	Cumulative Number of Responses
Baseline			
Trial 1			
Trial 2			
Trial 3			
Average:	BP/# of trials ____/____= _____	Sum of trails/ # of trials _____ /_____= _____	Sum of cum. num./ # of trials _____ /_____= _____

PR Geometric, MP	Breakpoint	Total Response Time	Cumulative Number of Responses
Baseline			
Trial 1			
Trial 2			
Trial 3			
Average:	BP/# of trials ____/____= _____	Sum of trails/ # of trials _____ /_____= _____	Sum of cum. num./ # of trials _____ /_____= _____

PR Geometric, HP	Breakpoint	Total Response Time	Cumulative Number of Responses
Baseline			
Trial 1			
Trial 2			
Trial 3			
Average:	BP/# of trials ____/____= _____	Sum of trails/ # of trials _____ /_____= _____	Sum of cum. num./ # of trials _____ /_____= _____

Appendix D

Fidelity Data Checklist

Participant: _____ Phase and Session #: _____
Rater: _____ Date of rating: _____

Mark an "X" in the appropriate box (Correct, Incorrect, NA) for the appropriate phase observed. Correct were steps completed correctly by the interventionist, incorrect steps were completed incorrectly by the interventionists, and NA were steps not applicable to the phase observed.

Phase: Baseline

Researcher Behaviors	CORRECT	INCORRECT	N/A
1. Researcher had all task materials in place prior to giving the participant a prompt to begin task.			
2. Researcher stated, "You are going to do (*task + model),* you can do as much as you want." Then placed materials in front of the participant.			
3. The researcher provided no other prompts or attention.			
4. If the participant stated he was done the researcher will terminated the session.			
5. If 2 minutes elapsed without a response from the participant the session was terminated.			
6. If the participant eloped and did not return to the table within 30-s the session was terminated.			
TOTAL: _____/ 6 x 100 = _____%	%		

Phase: Reinforcer Assessment, Additive

Researcher Behaviors	CORRECT	INCORRECT	N/A
1. Participant sat at a table with task materials and visually able to see reinforcer for the assessment.			
2. During the teaching trial, the researcher prompted, "If you want your (*reinforcer*), you have to finish your (*task+ model*)." Then researcher provided most to least physical guidance to complete the response.			
3. Researcher removed the task materials and provided reinforcer for 20-s upon completion of task.			
4. The researcher stated "my turn" while moving the reinforcer and replacing the task materials.			
5. The researcher stated on the first trial of the PR session, "first task".			
6. Session was terminated when participant subsided responding for 2 minutes.			
7. Researcher followed the PR algorithm and provided 20-s of reinforcement.			
TOTAL: _____/ 7 x 100 = _____%	%		

Phase: Reinforcer Assessment, Geometric

Researcher Behaviors	CORRECT	INCORRECT	N/A
1. Participant sat at a table with task materials and visually able to see reinforcer for the assessment.			
2. During the teaching trial, the researcher prompted, "If you want your (*reinforcer*), you have to finish your (*task+*			

model).” Then researcher provided most to least physical guidance to complete the response.			
3. Researcher removed the task materials and provided reinforcer for 20-s upon completion of task.			
4. The researcher stated “my turn” while moving the reinforcer and replacing the task materials.			
5. The researcher stated on the first trial of the PR session, “first task”.			
6. Session was terminated when participant subsided responding for 2 minutes.			
7. Researcher followed the PR algorithm and provided 20-s of reinforcement.			
TOTAL: _____/ 7 x 100 = _____%	%		

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